

SELECT COMMITTEE ON
SCIENCE AND TECHNOLOGY

DEFINITIONS OF
R & D

REPORT WITH EVIDENCE

Ordered to be printed 29 March 1990

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CONTENTS

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INFORMATION CENTRE

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R & D

Wellcome Centre for Medical Sciences
INFORMATION CENTRE

CONTENTS

	Paragraph	Page
REPORT		
BACKGROUND	1.1	5
Frascati Manual	1.12	6
Evidence to the Committee	1.17	7
HOW RELIABLE ARE DEFINITIONS OF R&D?	1.18	7
IMPROVEMENTS IN DEFINITIONS OF R&D?	1.30	8
Use of the Frascati Manual	1.31	8
Defence R&D	1.37	9
Discrepancies between surveys	1.42	9
Small Firms	1.45	10
Launch aid	1.48	10
DEFECTS IN THE FRASCATI MANUAL	1.49	10
Strategic research	1.50	11
OTHER DEFINITIONS OF R&D		12
Non-Frascati activity	1.63	12
Primary purpose	1.69	13
Personnel and Equipment	1.72	13
Technological balance of payments	1.74	13
STATISTICS AND R&D ASSESSMENT	1.79	14
INTERNATIONAL COMPARISONS OF R&D EXPENDITURE	1.82	14
Illustrations	1.90	15
CONCLUSION	2.1	20
Major Lessons	2.15	21
Appendix 1 — Membership of Sub-Committee II (Definitions of R&D)		22
Appendix 2 — List of witnesses and respondents to questionnaire		23
Appendix 3 — Summary of questionnaires sent to witnesses		24
Appendix 4 — Comparison of the Frascati and SSAP13 Definitions of R&D		32
ORAL EVIDENCE		
<i>Science Policy Research Unit</i>		
Written Evidence		41
Oral Evidence, 2 March 1989		42
<i>Sir Colin Fielding</i>		
Written Evidence		50
Oral Evidence, 2 March 1989		51

	Page
<i>Society of British Aerospace Companies</i>	
Written Evidence	56
Oral Evidence, 23 November 1989	61
<i>Confederation of British Industry</i>	
Written Evidence	68
Oral Evidence, 7 December 1989	70
<i>Ministry of Defence</i>	
Written Evidence	80
Oral Evidence, 8 February 1990	83
Letter from the Earl of Caithness	92

WRITTEN EVIDENCE

Respondents to the questionnaire in Appendix 3

Agricultural and Food Research Council	93
British Aerospace	56
Chartered Association of Certified Accountants	94
Chartered Institute of Management Accountants	95
Confederation of British Industry	68
Department of Education and Science	97
Department of Employment	97
Department of Energy	99
Department of the Environment	100
Department of Health	103
Department of Social Security	103
Department of Trade and Industry	104
Department of Transport	108
Economic and Social Research Council	109
Fellowship of Engineering	110
Health and Safety Commission	117
Home Office	118
Institute of Chartered Accountants of England and Wales	119
Institute of Chartered Accountants of Scotland	120
Medical Research Council	122
Ministry of Agriculture, Fisheries and Food	123
Ministry of Defence	80
Natural Environment Research Council	124
Northern Ireland Departments	127
Overseas Development Administration	128
Science and Engineering Research Council	134
Scottish Office	135
Training Agency	139
Universities Funding Council	140
Welsh Office	141
<i>Other written evidence</i>	
Hartley, Professor K, University of York	141
Organisation for Economic Cooperation and Development	142
Stoneman, Dr P, University of Warwick	143

Note: References in the text of the Report are as follows:

- (Q) refers to a question in oral evidence;
- (p) refers to a page of written evidence.

THIRD REPORT

29 MARCH 1990

By the Select Committee appointed to consider Science and Technology.

ORDERED TO REPORT:

DEFINITIONS OF R&D

BACKGROUND

1.1 The Committee have conducted an enquiry into definitions of R&D spending.

1.2 The subject arose out of the Committee's experience during a decade of enquiries. Science policy cannot be decided without reference to the amount of money spent on R&D. The importance of R&D cannot be measured realistically without a clear idea of what R&D is and why it is done. Yet the facts are clouded by uncertainty over definitions of R&D and false comparisons between like and unlike.

1.3 In the public sector, overall policy on R&D spending is settled to a large degree by comparisons—historical comparisons with the spending levels of past years or contemporary comparisons with the spending levels of other countries. Although some quantitative tests about the “health” of research can be employed, such as the flow of manpower and successful performance (assessed with hindsight), decisions about policy depend primarily on subjective judgement. The goals of science policy can rarely be assessed in absolute terms.

1.4 As the Committee said about spending targets in their report on Civil R&D published in 1987¹ “the most useful indicator of all is *international comparison*, even with its admitted imperfections. This is the key. Ultimately the goal is the United Kingdom's survival as a leading industrial nation in world competition. The United Kingdom must therefore spend sufficient to improve (or at least to maintain) its industrial and cultural base relative to those countries which are judged to be its natural competitors, making allowances for differences in size and resources”. A look at Hansard in the House of Commons confirms that such comparisons are often used in political debate². The Organisation for Economic Cooperation and Development (OECD) and the Statistical Office of the European Community (SOEC) devote considerable effort to the compilation of international R&D statistics.

1.5 R&D statistics are also used as a management tool in Government and as indicators of national investment. During the 1980s science and technology have moved from the periphery of Government policy to a more central position. A precondition of this was the production of Annual Reviews of Government Funded R&D. These Reviews have helped the Government to institute collective Ministerial consideration, under the Prime Minister's leadership, of science and technology priorities, and to determine the contribution of those priorities to national economic success and wider Government objectives³. Within overall spending targets the Government is now able to judge the balance between R&D and total expenditure and also the balance between different types of R&D.

1.6 The Committee have regularly advocated the disclosure of R&D spending by industry, believing not only that disclosure would be helpful to shareholders, but that it will also benefit the climate of opinion in industry which influences investment decisions. It should change those City attitudes which sometimes inhibit R&D. R&D has to be regarded as an investment which leads to growth, not as a cost. Accounting Standard SSAP13, revised in January 1989, now provides for the disclosure of R&D by public limited companies as an obligation of good accounting practice (see Appendix 4). SSAP13 will encourage industry management to look positively at its R&D spending both in relation to the spending of competitors and also in relation to turnover. The same opportunities will be available to City analysts.

¹ First Report (1986–87), *Civil Research and Development* (HL 20), para 6.16

² HC Deb 19 February 1987, cc 1056–7; 29 February 1988, cc 715–51; 7 February 1989, cc 865–900; 19 April 1989, cc 341–54

³ Government Response on Civil Research and Development, Cm 185, para. 7

1.7 The purpose of disclosure is to give accurate information. Comparisons between countries, sectors or firms must be fair. But the Committee have serious doubts about the reliability of some R&D statistics and the uses to which they are being put. In particular the definitions used are not the same everywhere. When policy is guided by statistics, in both the public and private sectors, every effort must be made to ensure that the statistics are reliable and used appropriately, which is the purpose of this report.

1.8 Another factor in this enquiry is the knowledge that the OECD's Frascati manual¹ is to be amended. This event is significant because the manual has become the main basis of statistics in the OECD area and beyond.

1.9 But the Committee sound a note of caution before going any further. Although there is some correlation between R&D and innovation, the volume and character of R&D constitute only a partial guide to scientific excellence or to innovative performance.

1.10 As the Frascati manual itself states (in paragraph 9): "Science and technology innovation may be considered as the transformation of an idea into a new or improved saleable product or operational process in industry and commerce or into a new approach to a social service. It thus consists of all those scientific, technical, commercial and financial steps necessary for the successful development and marketing of new or improved manufactured products, the commercial use of new or improved processes and equipment or the introduction of a new approach to a social service. *R&D is only one of these steps.*"

1.11 There is always a danger that those aspects of a complicated picture which lend themselves to quantification will receive undue emphasis in comparison with other elements about which only qualitative statements can be made. As Sir Robin Nicholson has said² "simple R&D statistics have their merit in that they are understood by Select Committees. However from an industry standpoint what is important is the total spent on innovation". But this admitted, R&D statistics are much more than academically important and they have a significant and evolving role in the setting both of public policy and of corporate strategies.

Frascati Manual

1.12 The OECD's Frascati Manual has, for almost thirty years, provided a basis for the measurement of scientific and technical activities. It sets out standard practice for surveys of "research and experimental development". Its formulae have been accepted world-wide among the OECD's member countries. Now its provisions have been incorporated into standard accounting practice in the UK as the foundation of SSAP13 (revised). Appendix 4 compares the definitions in the Frascati manual with those in SSAP13 and identifies the differences: these are few.

1.13 The Committee therefore accept the Frascati definitions as their starting point. It would be inconceivable to do otherwise. Whatever imperfections there may be in the Frascati manual, and there are some, there is no prospect that anything better would be achieved by starting from scratch and a great deal would be lost. Indeed, in the Committee's opinion, faults in R&D statistics more often derive from a failure to apply the Frascati definitions properly than from any shortcomings in the definitions themselves.

1.14 This report is not a detailed dissection of the Frascati manual, which runs to 120 pages of text; rather it is a commentary on some of the main areas in which the Frascati manual and British practice are potentially at odds. It focuses mainly on the Frascati definitions of types of R&D activity and on the borderline between R&D and other scientific and technological activities.

1.15 The main Frascati definitions are:-

basic research—"experimental or theoretical work undertaken primarily to acquire new knowledge of the underlying foundation of phenomena and observable facts, without any particular application or use in view";

applied research—"original investigation undertaken in order to acquire new knowledge. It is, however, directed primarily towards a specific practical aim or objective";

experimental development—"systematic work, drawing on existing knowledge gained from research and/or practical experience that is directed to producing new materials, products

¹The Measurement of Scientific and Technical Activities—Proposed Standard Practice for Surveys of Research and Experimental Development, "Frascati Manual 1980", OECD, Paris, 1981

²Quoted in the proceedings of a seminar on Innovation, Investment and Survival of the United Kingdom Economy (Institution of Mechanical Engineers, 14 July 1989).

or devices, to installing new processes, systems and services, or to improving substantially those already produced or installed”.

1.16 The Frascati manual goes wider than this. It classifies R&D not only by types of activity, but also by “institutional classifications”, ie who performs and pays for R&D, and by “socio-economic objectives”, ie why R&D is done. It also includes a chapter on the measurement of personnel devoted to R&D, as well as expenditure and it discusses the measurement of output of R&D. This report touches on these issues, but not in depth.

Evidence to the Committee

1.17 The enquiry revolved around questionnaires sent out to a number of witnesses in May and answered in July 1989. Preliminary evidence was taken in early 1989, largely with the object of deciding on the usefulness of the questionnaire approach. Then oral evidence was taken in the light of the questionnaire replies. The texts of the questionnaires are given in Appendix 3, and the replies are printed in full on pages 56, 68, 80, 93–141. Other evidence is printed on pages 41, 50, 141–4.

HOW RELIABLE ARE DEFINITIONS OF R&D?

1.18 As the Committee will demonstrate, definitions of R&D and the statistics based on them are always going to be subject to inconsistencies. They are useful as indicators but their finer details should be taken with a pinch of salt. They are easily misinterpreted.

1.19 The borderlines between different types of scientific and technological activity are not straightforward. If the borderline between R&D and related activities is drawn in the wrong place, the figure for total expenditure on R&D will be too high or too low. Within the total figure, the breakdown between types of activity may be in the wrong place and exaggerate one type of activity, eg basic research, at the expense of another, eg applied research. If comparisons are made between two countries or companies applying different interpretations of the definitions, the comparisons will be invalid. When year on year trends are observed, these will also be valueless if the change is produced merely by changing interpretation of the definitions.

1.20 The point at which interpretation is difficult varies according to sector. Research Councils seem to experience most problems on the borderline between basic and applied research. Industry has most trouble on the borderline between experimental development and related activities which are not R&D; the Ministry of Defence has the same difficulty. Civil departments of Government have difficulty with applied research and especially the line between the sub-divisions (applied strategic and applied specific) introduced in the Annual Review. (For a discussion of strategic research, see paras 1.50–62 below.)

1.21 Among the reasons for those difficulties and the uncertainties to which they give rise, the first is simply that few organisations use the Frascati definitions in their day-to-day operations. Even when they do, this may be inadvertent.

1.22 Most Government departments for instance categorise their R&D according to departmental objectives or to the budgeting requirements of the department's Vote from Parliament. Expenditure is lumped together within subject areas or policy objectives, without distinguishing between different classes of research, development or non-Frascati expenditure. It is only because departments are obliged to make a return for inclusion in the Annual Review of Government Funded R&D that they have to convert their expenditure to fit the Frascati definitions, on which the returns are based. The explanatory notes of the Government, rather than the Frascati manual, act as their guide. Several departments were unaware that the categories “applied strategic” and “applied specific” were a feature of the Annual Review, not of Frascati.

1.23 Similarly large industrial companies may use definitions of R&D based on Frascati but they tend to place greater emphasis on internal budget or departmental responsibilities, and the definitions develop a tenuous relationship with Frascati. “In smaller companies, even where research is the principal activity, the Frascati definitions are virtually unknown” (p 115). When companies seek to achieve uniformity of practice with other companies, it is the result as often as not of trade association activity. Trade association guidelines may be based on Frascati but are likely to be more concise and to the point than the Frascati manual.

1.24 The DTI's quadrennial survey of industrial R&D encourages companies to follow Frascati definitions. Nevertheless it is likely that many companies when responding to the survey use operational definitions peculiar to them. SSAP13, which is based on the Frascati definitions, should bring companies gradually into line with standard definitions, for accounting reasons, though it will not require any differentiation between research and development.

1.25 Even when the same definitions are being applied, there is an opportunity for subjectivity in deciding what activities fit where. Many witnesses acknowledged the degree of subjectivity involved. For example SERC, describing the Frascati definitions as “fairly well suited to their purpose”, added that any definitions will “always be to some degree subjective” (p 134). Significance attaches to year on year changes in R&D statistics, less to comparisons between organisations or countries. In the same vein, AFRC found the Frascati definitions of basic and applied research “open to wide interpretation” (p 93). Only by employing the same individual to collect statistics from year to year can consistency be achieved even within a single organisation.

1.26 In line with these observations is the CBI view that, because detailed guidelines are often provided by companies or trade associations, statistics for R&D spending are more consistent within industrial sectors than across different industries (p 69). Comments from the several institutes of accountants imply that before the revision of SSAP13 the use and understanding of Frascati varied widely among companies; subjectivity is inevitable; even the revised SSAP13 is unlikely to make much improvement in comparability between enterprises.

1.27 Surprisingly the DTI, as collators of the Annual Review, claimed not to know of “any important degree of subjectivity” in the returns made to it by respondents (p 105). However, in respect of its own return it acknowledged that “a certain amount of subjectivity inevitably arises”. It also indicated that no special effort was made to uncover inconsistencies.

1.28 The MoD believe that subjectivity in its area is low but this opinion has to be set against the substantial reservation which the Committee take up below: the MoD’s figures do not seem to be calculated on the same basis as those of other organisations.

1.29 It seems clear that the problem of subjectivity does not occur because of the particular Frascati definitions but rather would be inherent in any definitions. It is also apparent that proliferating categories in the Frascati definitions would merely invite more subjectivity. Any detailed analysis, which an increase in the number of categories would make possible, would prove in practice to be largely spurious. Accuracy seems likely to be greatest when a single global R&D figure is quoted, since in that case the only difficulty lies in deciding what is and is not R&D, and there is no internal problem of classification.

IMPROVEMENTS IN DEFINITIONS OF R&D

1.30 The Committee suggest three avenues through which definitions of R&D might be improved. The first is to make the Frascati manual more approachable and to give more help to those who use it and its derivatives. The second is to correct any obvious misinterpretations of the manual. The third is to remove any defects in the manual itself.

Use of the Frascati manual

1.31 The Frascati manual is a daunting document. Maybe this is unavoidable if its main purpose is to support OECD’s analyses. If it is accepted that there is merit in encouraging conformity of definitions within industrial companies and sections of Government, then the manual can be seen in a different light. It should be made more user-friendly, in order to gain more widespread use.

1.32 Few organisations can be expected to think naturally in the first place in terms of the Frascati definitions. For companies and Government departments the collection of information on R&D spending is primarily a matter of good business practice, and there is no reason for this collection to be much influenced by requirements external to the organisation. As long as the organisations are prepared to make the effort to convert their R&D statistics into common form for publication, internal practices can ignore the Frascati definitions. However there is an obvious cost in the conversion and also some scope for the introduction of inaccuracies. It may be that, under the influence of the Annual Review and SSAP13, some conformity will become the norm. This will be speeded up if the manual is simplified.

1.33 One organisation which, unusually, is trying to think directly in Frascati language is the ESRC, and it is attempting this precisely because of its earlier difficulties in converting its internal R&D statistics into Frascati terms for the Annual Review. Even the ESRC states that in using Frascati it is “never very clear” whether one is categorising the objective, the methodology, the likely results, or the whole package (p 110). In short, the Frascati definitions appear to be used not because they are ideal, but because they are there.

1.34 The OECD could help users of the manual by the provision of more detailed guidelines backed up by an abundance of examples. Those examples could be provided in manuals or via

seminars. Perhaps, since different sectors experience different problems, there would have to be different sets of guidelines, or at least different examples, for the various sectors. Since the aim is clear—to make the definitions less dependent on who exactly fills in the relevant forms and in which organisation—examples should be as diverse or sector-specific as possible.

1.35 The DTI and the Central Statistical Office can also contribute a lot to this process. There is general concern in industry about the lack of feedback from the DTI: as one company said about the DTI's industrial survey, it is a bit of a "black-hole exercise" in which companies are never quite sure whether they are providing the DTI with the right information or not. Other companies shared the feeling that DTI tends to accept the figures offered without question. DTI should at least mount a follow-up exercise to its survey to get a feel for how good the data are, how they tally with disclosures in company accounts, and how they could be improved. The Central Statistical Office, which has taken over compilation of the Annual Review from the DTI, should adopt a more questioning attitude to departmental returns than the DTI, which evidently took returns largely at their face value.

1.36 Even with these precautions, subjectivity will still remain. It remains to a significant extent, for instance, in Canada where a substantial team of specialists has been recruited to assess R&D claims for tax purposes against a set of common and agreed definitions. In short, subjectivity is something to be lived with, while taking such steps as are cost effective to reduce its impact. An effort on the Canadian scale could hardly be justified in the UK unless there were comparable tax implications.

Defence R&D

1.37 One sector in which an urgent change is called for, above all because of the magnitude of the sums involved, is defence R&D. It has been alleged by the SBAC (QQ 97–127) and the CBI (Q 172) in evidence, and by many others elsewhere, that MoD definitions of R&D are not the same as the civil sector's, that they do not conform to the Frascati definitions, and that not more than half the MoD's annual expenditure of £2.3bn on R&D supports "true R&D" as generally understood.

1.38 The MoD says of its figures that they are "broadly in line with the Frascati definitions. We do this by reporting on the blocks of expenditure from our accounting systems ... Since these systems were created with the needs of financial accounting and accountability in mind questions of classification arise in certain areas. The extent of these is currently being studied" (p 80). In oral evidence they rejected the criticisms of their figures on the grounds that their in-house studies do not yet provide a sufficient statistical basis for valid conclusions to be drawn (QQ 225–7). Nothing in their evidence gave any sign that the matter was regarded as urgent or that the concern expressed by others was shared by the MoD.

1.39 The Committee find the MoD's position very unconvincing. This does not imply any criticism of what MoD spends—there are doubtless good reasons for the expenditure and the money has been voted by Parliament for that purpose. But the Committee feel certain that much of what is now classed as defence R&D is not R&D at all on any reasonable interpretation of the Frascati definitions. When defence R&D appears to be about 50% of the UK total spending on R&D, that matters a great deal.

1.40 The major distortion lies within MoD's figures for development, because MoD include in that all activities, whether innovative or not, which precede actual production. The MoD fairly point out that Frascati does not deal with defence-specific items, and that very few other departments have big procurement budgets. But with reference to development contracts "companies from several different sectors stated that almost all defence contract work is normally counted as R&D by the MoD, although much of this is essentially product development involving 'no appreciable element of novelty'" (p 69). Strenuous efforts should be made, as a matter of urgency, to get the figures right.

1.41 The ACOST report on Defence R&D has recommended that MoD should publish its R&D data according to the research and development definitions of the Accounting Standards Committee in order to facilitate comparison with private sector information. The Committee fully support the intention behind this recommendation but point out that SSAP13 does not require differentiation between research and development. MoD must continue to differentiate, and must follow the Frascati definitions so that international comparison is feasible.

Discrepancies between surveys

1.42 One indicator that something is awry in defence R&D is the apparent discrepancy, identified by the Annual Review, between what MoD says it funds in industry and what industry claims to receive from MoD. The discrepancy is not small. In 1985 MoD's reported expenditure on industrial R&D (£1516m) was 50% higher than the expenditure reckoned by industry to have been received from MoD (£1012m).

1.43 The Annual Review (para 2.2), referring to the DTI's industrial survey in 1985, explains this as follows: "The industrial survey collects statistics of R&D carried out within the responding organisation (intramural R&D) irrespective of the source of funding. They are also asked to give information on the funding of that R&D by the Government, from overseas, and by the firm itself and other sources. This method of collecting intramural R&D expenditure avoids double counting and is the approach adopted by other OECD countries. The approach does however lead to certain apparent differences when the figures which industry produces for R&D performed by them and funded by Government are compared with the contrasting statistics from the Government Survey for R&D funded by Government but performed in industry. The reasons for the differences include:

- (i) the industrial survey is directed to enterprises with 200 or more employees but there is no lower limit in the data collected in the Government survey;
- (ii) a company sub-contracting from another company may not recognise the Government as the ultimate source of funds;
- (iii) a company sub-contracting from another company may not appreciate that the work it is carrying out is an essential element of the contracting company's R&D programme and may not therefore classify it as R&D in the industry survey;
- (iv) the returns from industry and Government are treated differently in respect of profit related elements. The Government expenditure figures include the profit element of any R&D contract placed with industry. The industry figures, however, exclude profit".

1.44 The Committee accept that these reasons may partly explain the discrepancy and similar problems may arise in other OECD countries. But they consider the discrepancy too large to be acceptable. It must be reduced. The aim is accuracy in both the Annual Review and SSAP13 returns and as close a reconciliation as possible between the two. The way forward here might be for the statisticians to undertake a detailed survey in a sector where the discrepancies are particularly large. The Committee have no wish to promote an "engineered fit" between the statistics collected by different routes but see efforts to minimise discrepancies as likely to increase the quality of the figures overall.

Small Firms

1.45 Among the reasons for the "apparent discrepancy" given above was the exclusion of small firms from the DTI survey. However evidence from the MoD (QQ 278-84) and DTI (see below) seems to indicate that the contribution of small firms to this discrepancy is not great. If so, the other reasons for the discrepancy assume greater importance. The small firm issue cannot be dismissed lightly: its significance ought to be tested.

1.46 The DTI believes that its four yearly benchmark survey of private industrial R&D captures 99.5 per cent of the total and that its yearly survey covers 75 per cent of the total. The surveys include firms employing more than 200 people and DTI's confidence is based on the fact that when industrial firms employing between 100-200 people were last surveyed, in 1975, their contribution to the total of private R&D was less than 0.5 per cent. Omitted even from the four year benchmark survey are firms of less than 100 employees. Some at least of these, for instance those established on Science Parks, can be expected to be R&D rich.

1.47 Reliable information about R&D in small firms could be of considerable policy relevance. Even though large established firms make up the bulk of a country's private R&D, the development of new firms is of critical long-run importance to the economy. It would be undesirable to add to the burdens on the smallest firms by requiring them to fill in forms simply to get greater accuracy in the last one per cent of national R&D figures. On the other hand, the DTI might consider it worthwhile commissioning studies to shed more light on the small firms issue. This would probably be more cost effective than aiming to include the firms in the benchmark surveys.

Launch aid

1.48 It is surprising that Civil Aviation Act launch aid is included in the DTI's Frascati returns. Launch aid is concerned with setting up production facilities in a company. A possibility of double counting also exists if launch aid is included both in the company's total R&D spending and in that of the DTI (Q 147); clearly this should be avoided. The Committee suggest that formal consideration should be given to the place of launch aid in the Annual Review figures.

DEFECTS IN THE FRASCATI MANUAL

1.49 Few specific defects in the Frascati manual were identified during the enquiry, and the Committee did not consider it their business to search for them. The most immediate which came to light was lack of coverage of software research. The OECD are already aware of this. The largest defect concerns strategic research.

Strategic research

1.50 "Strategic research" is a major item on which the Frascati manual is silent. The Committee over the years have favoured strategic thinking and not surprisingly therefore have also pressed the case for more strategic research. The Annual Review has modified the Frascati definitions to introduce the concept of strategic research (see Annex B of the Annual Review 1989, p.210)—this has been done by subdividing applied research into "applied strategic" and "applied specific". The OECD are understood to be considering whether the Frascati definitions are imperfect in this respect.

1.51 Strategic research is defined in the Annual Review as applied research in a subject area which has not yet advanced to the stage where eventual applications can be clearly specified. It has been defined by the Select Committee as research undertaken with eventual practical applications in mind even though these cannot be clearly specified¹. Other authorities have defined it as basic research carried out with the expectation that it will produce a broad base of knowledge likely to form the background to the solution of recognised current or future practical problems².

1.52 Four of the Research Councils would welcome the formal introduction of a strategic category into Frascati; the fifth, MRC, would prefer a classification system which combined basic and strategic research in one category, leaving applied research in another. Either change would allow greater precision in their returns for the Annual Review. Several Government departments favoured having a strategic category, including some which cited the Annual Review's sub-division of applied research as a reason why Frascati does not need the addition of a strategic research category—in the Committee's opinion this is actually an argument in favour of amending the Frascati definitions. The Scottish Office, while seeing some merit in a strategic category, was one of those which cautioned against too much refinement: "There is a distinct danger that such refinement will give the impression of a deeper and more precise analysis of the research programme than is justified by its determination in practice" (p 137).

1.53 There is an important difference of opinion between the scientific community and industry about what strategic research is. For the former group, strategic research is primarily concerned with providing a knowledge base for future applied research and also with monitoring the natural world. For industry it is primarily curiosity-driven research as part of a long-term strategy supporting the company's performance.

1.54 Since SSAP13 does not differentiate between research and development and requires companies to declare only an aggregate figure, there is unlikely to be any move from industry in favour of subdivisions of research. The CBI said that their members were against introducing an additional category of strategic research. It is arguable that increased categorisation is undesirable since the aggregate figures are less open to misinterpretation than the component parts. Those to whom the category of strategic research is important are not prevented from getting the information which they want through intramural amendment of the existing definitions, as is done in the Annual Review.

1.55 The Annual Review requires strategic research to be allocated to the applied category. But it is arguable whether this is appropriate. The issue is not merely a matter of semantics because

¹First Report (1986–87), *Civil Research and Development*, HL 20, para 2.1. For further discussion of strategic research, see paras 2.9–12 and 6.62–67 of that report

²*Foresight in Science*, J Irvine and B R Martin, 1984, p4

wrong orientation could have repercussions on funding in the public sector, especially in the Research Councils.

1.56 In essence the Research Councils spend their own, Science Vote, money on basic research and other people's money in the form of commissions on applied research. (This is admittedly an oversimplification but it lies at the heart of the customer/contractor principle on which research funding in the public sector is based.) If strategic research is a sub-set of applied research, this creates a presumption that external funding should be found for it. But the policy advocated by the present Government and by this Committee in the past decade has been to increase the strategic content of Research Council spending. The Research Councils, while committed to the support of basic research, frequently and rightly fund work which could have eventual applications. This fact suggests that strategic research is a sub-set of basic research as well.

1.57 This difference of interpretation is clearly illustrated in the fields of medicine and defence. The MRC spends 22% of its budget on basic research. The Ministry of Defence spends none. The MRC has always maintained the importance of a large nursery of basic research from which can spring new ideas capable of development and researchers competent to tackle new problems as these arise. The MoD in evidence (QQ 232–5) said that they could fund only research which had an ultimate defence application. Even if the research which they funded—for instance materials science—might have been categorised as basic when funded by someone else, it could not strictly be called basic in their case. The Committee do not criticise either the MRC or the MoD for the definitions which they use, but point out what a fine distinction exists between research for the advancement of knowledge which can be applied in medicine and research for the advancement of knowledge which can be applied in defence.

1.58 It can be argued that this difficulty of deciding whether strategic research is applied or basic does not matter. Where total figures of R&D are concerned, that is true. But from a policy point of view it matters greatly.

1.59 In the first place, the publication of R&D figures is intended to add clarity to policy-making. When a fairly large segment of research will not fit snugly into either of the two Frascati sub-divisions of research, one can be fairly sure that some such research will fall one side of the line and some the other. This will create distortions. It is probable that in subsequent years different people will allocate research differently, leading to an apparent shift of research effort between categories, from basic to applied research or in the opposite direction. Yet no real shift may have taken place. So the lack of clarity could be misleading.

1.60 Secondly the funding of strategic research could be made more difficult. The charter responsibilities of the Research Councils encourage them to favour basic research. This is perfectly fair. The Government's recent policy on near-market research reinforces this tendency, because the Research Councils are being obliged to keep away from research which has direct market applicability. On the other hand, those who commission research, whether in the public or the private sector, want to see results for their money. Accordingly they are likely to lean in favour of research with the prospect of short term application rather than strategic research where the results are, by definition, remote.

1.61 This suggests that the Frascati manual should be amended to cater better for strategic research. This could be done in two ways, either by making clear where in the existing definitions strategic research should be placed, or by increasing the number of categories.

1.62 The Committee prefer the first option, of locating strategic research clearly within the existing categories. Close attention, together with guidelines and examples, will be needed to establish the concept. The best way forward would seem to be via an international working group examining sufficient cases to enable the preparation of a definitive manual. When the Frascati definitions were originally laid down, the significance of strategic research was not as clearly recognised as it is now and the existing definitions are weaker as a result.

OTHER DEFINITIONS OF R&D

Non-Frascati activity

1.63 The Committee have already made the point that R&D is not the whole of scientific and technological activity. That which falls outside the Frascati categories should not be overlooked.

1.64 Coupled with the R&D expenditure of Government departments, and sometimes included in it, are a variety of non-Frascati activities. These include technology transfer and demonstration activities, and survey and monitoring programmes. Some of these have not been

included in the Annual Review. There will also be exclusions which are specific to particular departments, for example parts of the Energy Department's energy efficiency initiatives, or operational analysis carried out by the MoD.

1.65 Companies have tended to include in their Annual Reports and Accounts expenditure on activities such as technical services which are not covered under the Frascati definitions. In theory, the revised SSAP13 should go far to remove this particular problem in that it excludes activities peripheral to R&D. Practice may, however, be a different matter, since on the one hand the few companies which already declare their R&D can be expected to resist a change which would in effect lead to their showing a reduction in that expenditure, and on the other hand SSAP13, even as revised, seems flexible enough not to require their doing so.

1.66 One related trend should move in the reverse direction. Expenditure on the development of new manufacturing technology has hitherto been under-recorded in R&D statistics. It may instead have been included in manufacturing overheads, especially if the work was done in planning or manufacturing departments rather than traditional research or product development departments. Expenditure in this growth area should now be included in R&D under the provisions of SSAP13.

1.67 In the fields of environmental research and the social sciences, for example, the components of survey and monitoring are essential activities. They may not be research, strictly defined, but without them research is liable to be defective or impossible. The Annual Review is right to record scientific and technological activity, which is not R&D within the Frascati definitions.

1.68 The Committee suggest that, in the revision of the Frascati manual, attention should be given to the recording of those related activities which support R&D as currently defined.

Primary purpose

1.69 The Annual Review contains tables giving R&D expenditure by Primary Purpose. Seven primary purposes are defined as falling within the Frascati definitions:

- the advancement of science
- support for policy formation and implementation
- improvement in technology
- support for procurement decisions
- support for statutory duties
- support for the humanities
- support for other activities

and two as lying outside:

- technology transfer
- other science and technology expenditure.

1.70 Primary Purpose categories refer to why R&D is being done, in contrast with the Frascati categorisations by type of activity which relate to what R&D is done. This legitimate classification is needed to make the Annual Review useful for ministerial discussion of priorities. The fact that such distinctions are not made in the Frascati manual is unimportant.

1.71 The Frascati manual uses "socio-economic objectives"¹ to refer to why R&D is done. In this respect the Annual Review tabulates government funding by socio-economic objective in its section on International Comparison (agriculture, forestry and fishing; industrial development; energy; health; advancement in knowledge; civil space; other civil; defence).

Personnel and Equipment

1.72 For some purposes it can be useful to know the number of personnel involved in R&D in a company or project. Such information would, for instance, be relevant in discussions of national manpower planning and provision. The OECD already collect such statistics and the Annual Review has begun to do the same. It is clear that knowing the number of R&D personnel involved is no substitute for expenditure information, for several reasons. R&D varies greatly in its capital intensity, not everyone engaged in R&D is necessarily engaged full-time, personnel counts may

¹These are closely related to the NABS objectives used by the SOEC

miss those who assist but who are not qualified scientists or engineers, and parcels of R&D are not uncommonly contracted out. But there is a case for developing as many R&D indicators as possible, and though the cost effectiveness of obtaining them should not be ignored, information on R&D manpower is potentially one thing worth having.

1.73 Among the other indicators which the Committee commend is detailed statistical information on the character, age and quantity of scientific equipment available in university and polytechnic laboratories.

Technological balance of payments

1.74 Even if, as the Committee wish, substantially more public and private R&D were undertaken in the United Kingdom, the United Kingdom can still be expected to perform less than 5% of the world total of R&D. This figure is likely to fall as the newly industrialising countries expand their R&D bases. It follows that the ability to exploit the world's stock of R&D is of fundamental importance.

1.75 Drawing successfully on this stock has never been easy, and the task may be getting harder. Success here depends both on the terms on which the world's stock of R&D results are available, and on indigenous capacity to recognise, obtain and exploit those results. Many R&D results are naturally private and protected, and others will tend to be available only on expensive and/or restrictive terms. Even so, the resource is too important to be ignored, and it is reasonable to ask whether the United Kingdom is as well organised as it could be to benefit from overseas R&D. Unfortunately Britain seems more comfortable exporting technology than importing technology which is "not invented here".

1.76 Over the decades when the British balance of payments has been causing concern, consolation has been taken in the fact that at least the country was running a positive balance where technology was concerned. This, however, should itself have been seen as an undesirable state of affairs. A negative technological balance of payments reflects not some national inadequacy but a willingness to exploit R&D of foreign origin.

1.77 To draw attention to this important point the Committee would welcome the inclusion in the Annual Review of as much data on the technological balance of payments as can be produced at reasonable cost, together with such international comparisons as are feasible and relevant.

1.78 There has also in recent years been a considerable expansion in collaborative R&D. Much of this has been under the auspices of the European Community. The costs and risks intrinsic to R&D make it likely that international collaborative initiatives will continue to grow in importance. Thought should therefore be given to including in the Annual Review such statistical information as would facilitate judgements on existing collaborative undertakings and new possibilities as they arise.

SATISTICS AND R&D ASSESSMENT

1.79 Traditionally, R&D statistics have been rather passive indicators. As normally collected, they do not allow any indication of the quality or output of the R&D being performed. More specifically, while they capture the level of everyday R&D, they cannot identify the occasional instances of scientific flair which lead to a decisive advantage.

1.80 In recent years attempts have been made to change the climate of government R&D, and the gathering of relevant statistical information has a contribution to make to this. The new approach is epitomised by the recent Cabinet Office publication 'R&D Assessment'¹. This document quotes with approval the Committee's recommendation in their report on Civil R&D that about 1% of an R&D budget should be spent on assessment².

1.81 R&D assessment aims to be a guide to clear thinking about research and development programmes. The Vote mechanism was never designed to encourage clear thinking about such programmes. On the contrary, it allowed, perhaps even encouraged, vagueness of thought. If the guidelines in 'R&D Assessment' are followed, this situation should change. It is not unreasonable

¹It is notable that this Guide brackets "basic and strategic" science together, refers to R&D ranging "from curiosity driven research at one end of the scale to mission directed R&D at the other", and scarcely uses the term "applied research" at all. This is a good example of the confusion which can be created by multifarious definitions of R&D.

²R&D Assessment: A Guide for Customers and Managers of Research and Development, HMSO 1989, p26. Civil R&D, 1st Report (1986-87) HL 20, para 6.116.

to expect that a more focused approach to R&D will lead to greater precision in the collection of R&D statistics. Better R&D statistics should in turn facilitate clearly thought out R&D programmes.

INTERNATIONAL COMPARISONS OF R&D EXPENDITURE

1.82 International comparisons of R&D spending have assumed great significance which is reflected in the continuing debate about the UK's position in the R&D league table. The level of R&D spending is seen as a measure of a nation's investment in its future.

1.83 International comparisons are, however, fraught with pitfalls. When making comparisons it is important that: (1) the basis on which the comparison is being made is properly understood; (2) the selective use/misuse of R&D statistics is avoided; and (3) as far as possible like is compared with like. Factors such as the growth of R&D by multinational companies have to be taken into account. At best the comparisons will be crude indicators.

1.84 Gross Expenditure on Research and Development (GERD), which includes **all** domestic expenditure on R&D, is used by the OECD as the basis for international comparisons. Although GERD enables the total amounts that different countries spend on R&D to be compared, it is not widely used for comparative purposes because it does not relate R&D expenditure to the size of the economy concerned (ie to the total national resources available). This is overcome by expressing GERD as a percentage of GDP.

1.85 Many of the problems with comparative R&D statistics arise following the breakdown of GERD (or GERD as a % GDP) into its constituent parts: ie between private (mainly the 'Business Enterprise' sector) and public ('Government') funded R&D, or between 'civil' and 'defence' related R&D.

1.86 The OECD suggest that when comparing GERD as a % GDP it is important to take account of the distorting influence that major defence programmes, in some OECD countries, have on the total figure. In this respect the United Kingdom is second only to the USA in the percentage of Government funds which are devoted to defence R&D (on the basis of current MoD definitions). The OECD have said that estimating civil R&D alone "sheds a different light on the state and characteristics of research in OECD countries and areas"¹.

1.87 The OECD also note that when comparing trends in GERD as a % GDP it is important to identify which of the two components, GERD or GDP, has had the greatest influence on the ratio. The OECD go on to suggest that a better indicator of a country's R&D effort is obtained by comparing growth in GERD against growth in GDP (see paragraph 1.103).

1.88 Another measure which OECD have developed is the ratio between GERD and Gross Fixed Capital Formation (GFCF). The GERD/GFCF ratio compares investments in R&D with traditional investments in fixed assets and provides an indicator of a country's capacity to incorporate technological progress. The OECD use GERD as a measure of "non-physical investment" in scientific and technological knowledge (ie R&D which is capable of generating innovations), and GFCF to measure "physical investment" in fixed assets, such as plant and equipment and construction (ie that investment necessary to exploit inventions). In general smaller countries invest proportionately less than the larger countries in R&D, but devote a higher percentage of their resources to traditional investments.

1.89 Here again it is necessary to identify which component in the ratio, GERD or GFCF, is more important. Four countries, West Germany, Sweden, the United States and the United Kingdom, have a higher GERD/GFCF ratio than other countries; however in the case of the United States and the United Kingdom this is due to lower shares of physical investment in GDP (ie GFCF is lower). As the OECD note, the case of Japan warrants further explanation because the GERD/GFCF ratio is more typical of that of a medium sized country. However what this fails to show is that the Japanese ratio is low only because of exceptionally high physical investment, ie GFCF represented 28% of GDP in Japan in 1983, compared with an average of under 20% in other major industrialised countries. The OECD believe that the interaction of these two types of investment (ie R&D and physical) helped the Japanese economy absorb technical innovations (ie exploit R&D) more quickly than the other large OECD countries—"an economy that is expanding more rapidly than others is able to renew its plant faster, and, consequently, to incorporate technological advances sooner"². This has important implications for all nations since it suggests that investments in R&D cannot be viewed in isolation from more traditional investments which facilitate the exploitation of that R&D.

¹OECD Science and Technology Indicators, Report No 3, 1989, p21

²OECD Science and Technology Indicators, Report No 2, 1986, p19

Illustrations

1.90 To illustrate the comparisons explained above, and to show how they may be used, the Committee take examples from three ministerial statements made recently in Parliament.

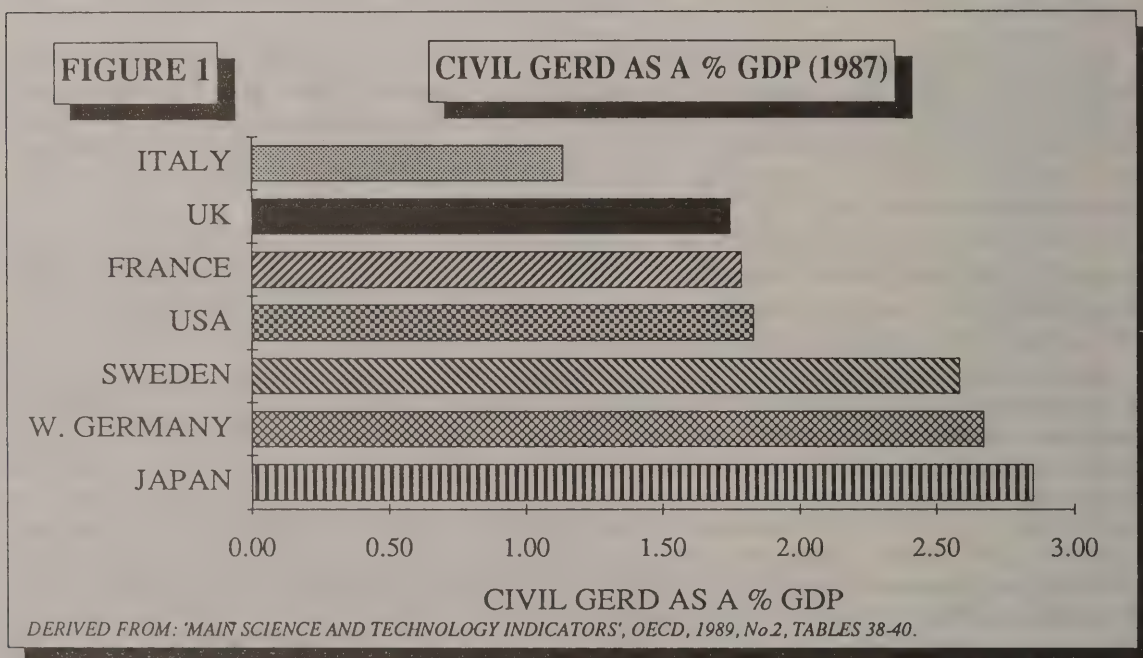
"... overall net Government expenditure on research and development is at a record level. United Kingdom Government-funded civilian research and development as a proportion of national output exceeds the level in Japan and the United States. My hon. Friend mentioned Germany. It is also true that for all research and development our expenditure as a proportion of national output exceeds that of Germany, so we have a much better record than many people realise." *Prime Minister, 19 February 1987.*

"... our financial inputs as a proportion of GDP are broadly in line with those of our competitors. No one can say that those are out of line or that we are markedly under-performing in one of those indicators." *Mr R Jackson, (Parliamentary Under Secretary of State for Education and Science) 29 February 1988.*

"... on total expenditure on R&D as a percentage of GDP, we are in the middle of a group consisting of France, West Germany, Italy, Japan and USA." *Earl of Caithness, (Paymaster General) 5 December 1989.*

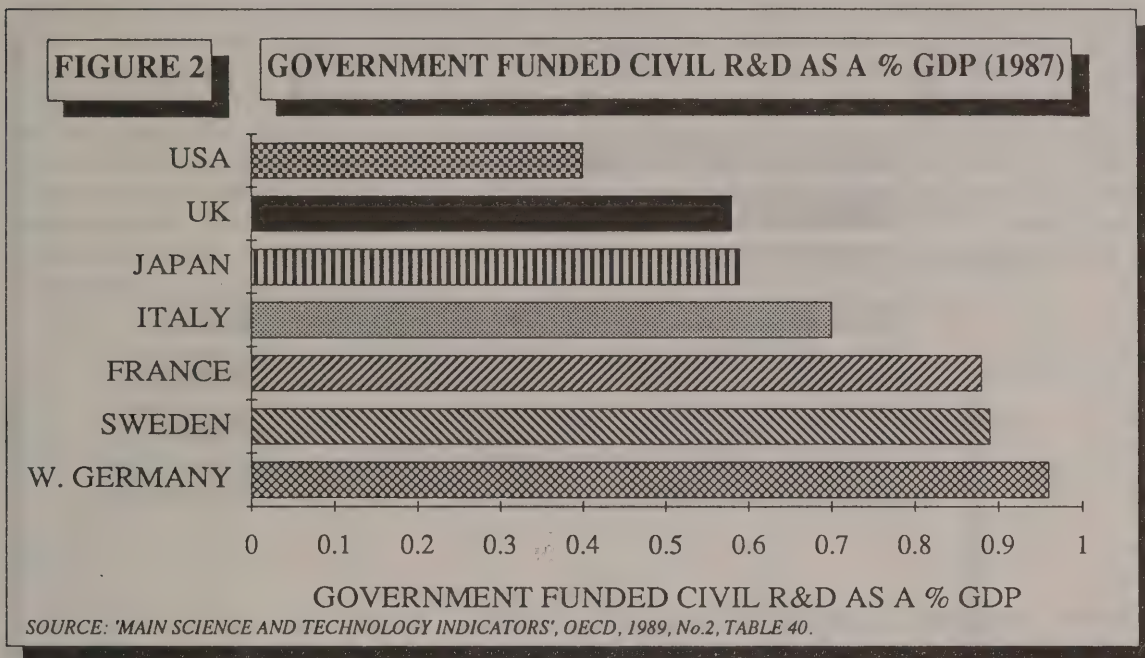
1.91 The significant feature of these quotations is which comparisons were chosen.

1.92 The Prime Minister was answering a question about "the disappointing level of civilian R&D in this country compared with Germany and Japan". A strict comparison, in answer to this question, would look at figures for total civil R&D (Government funded and privately funded) as a proportion of GDP. Such figures are as follows:-



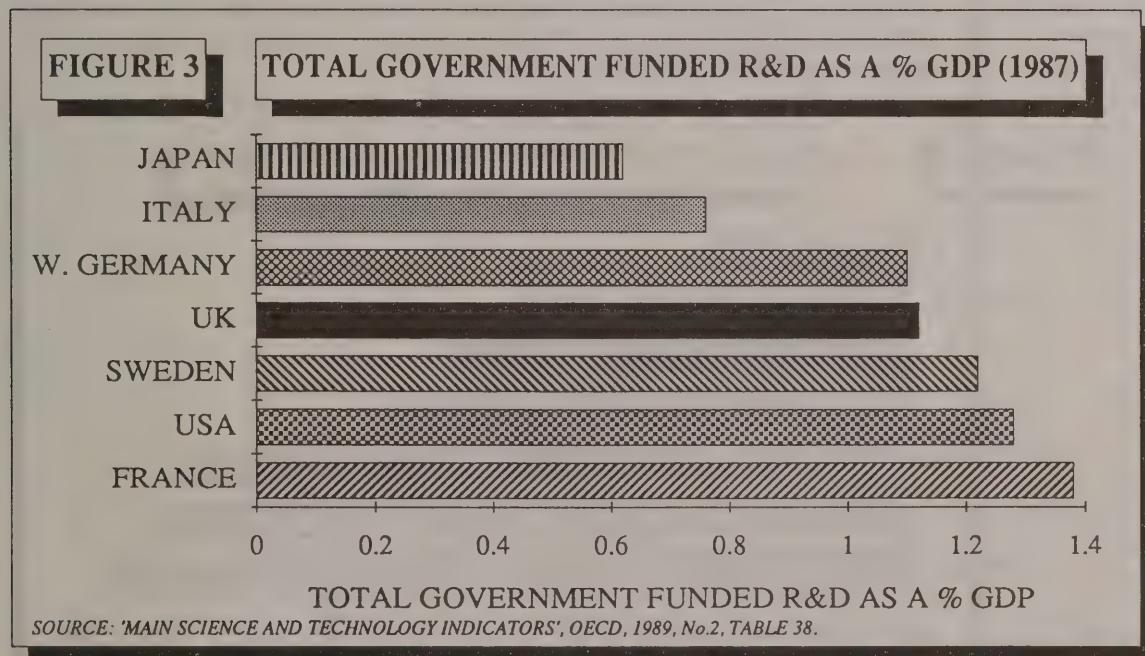
1.93 It may be noted that, on this basis, the United Kingdom's performance is below the level of Japan, Germany, and the United States.

1.94 The Prime Minister's comparison looked instead at figures for Government funded civil R&D as % GDP:-



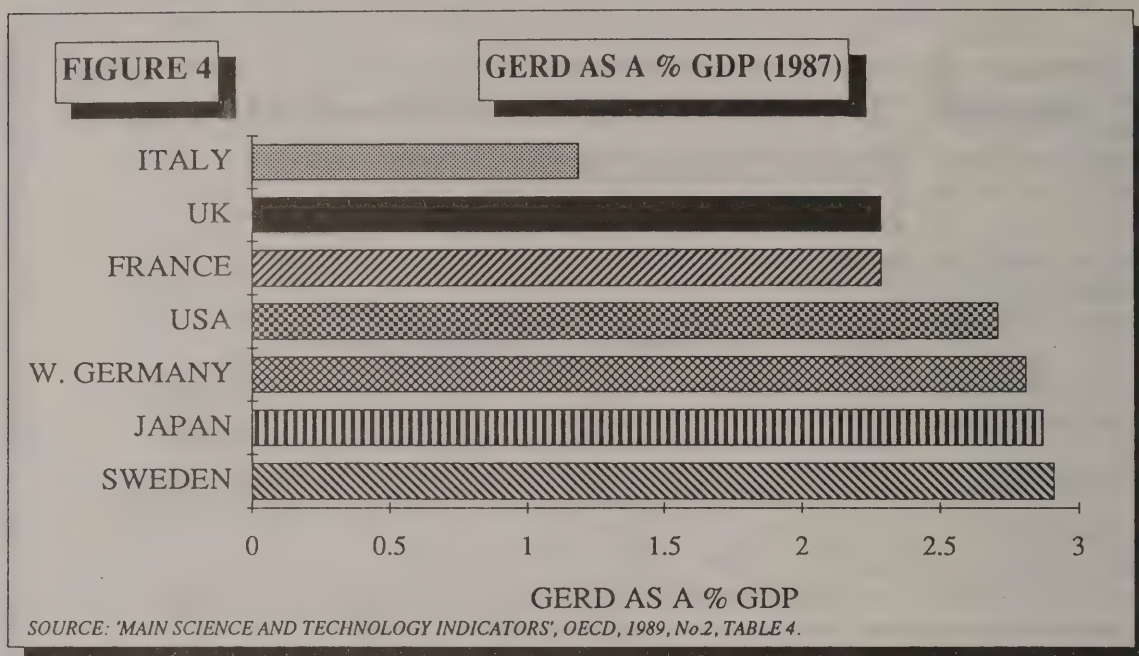
1.95 On this basis, the United Kingdom's performance in 1983 (to which her answer related) was above the level of Japan and the United States but below that of Germany; it is now below the level of Japan as well.

1.96 Her second comparison introduced defence R&D into the comparison of civil R&D. Total Government funded R&D as % GDP is as follows:-



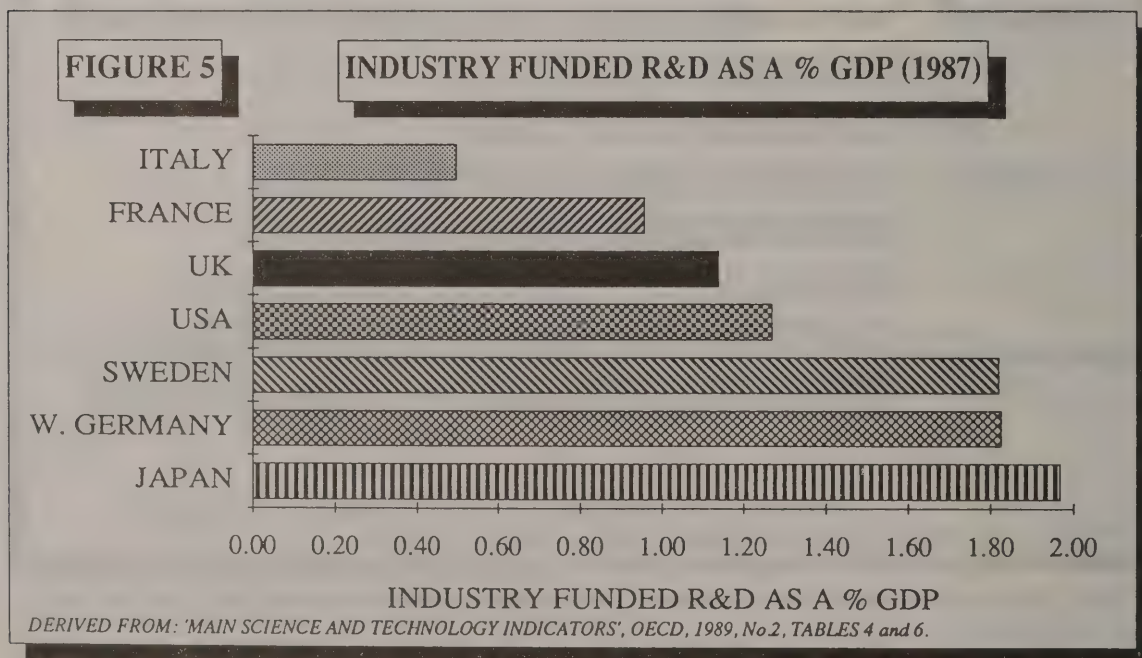
1.97 On this basis, the United Kingdom's performance is above Germany and Japan but below the United States.

1.98 If however the comparison, still including defence R&D as well as civil, had covered total R&D (GERD), the figures would be as follows:-



1.99 On this basis, the United Kingdom's performance is below the level of Japan, Germany and the United States.

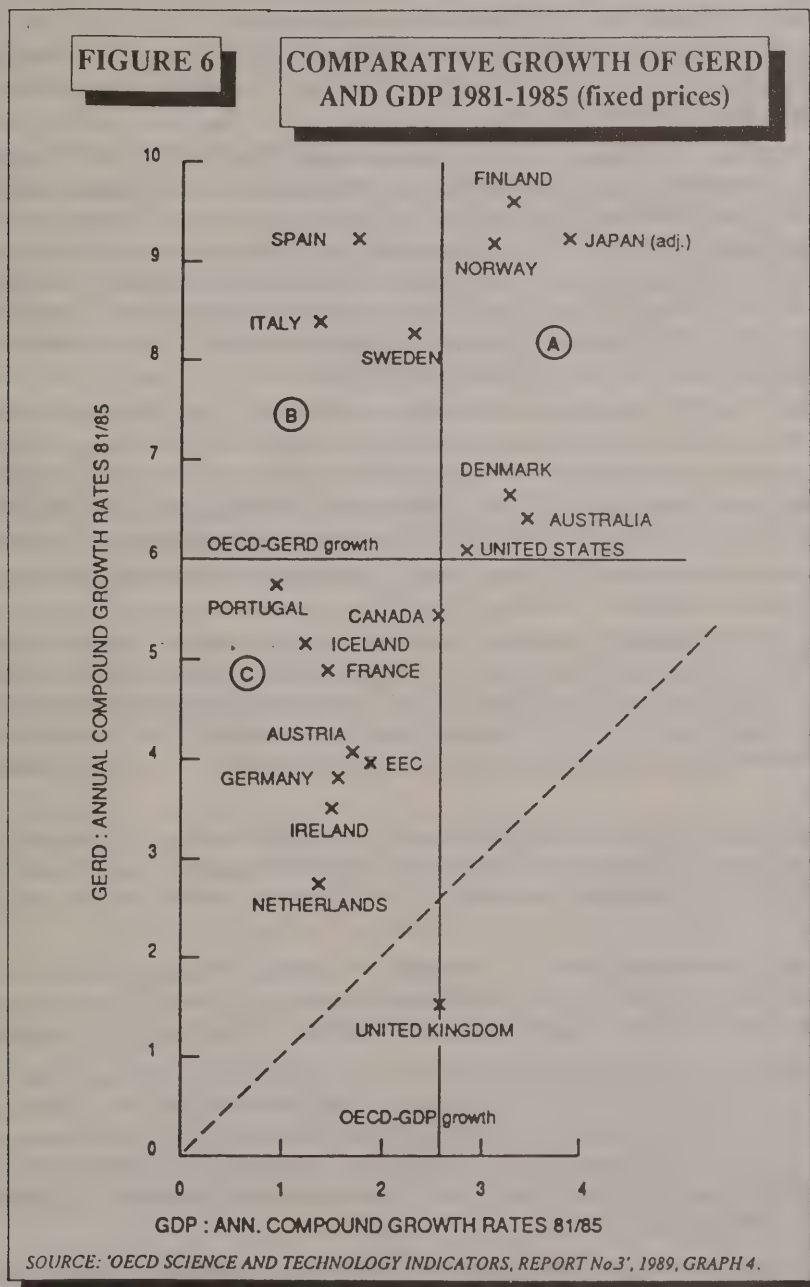
1.100 Lord Caithness's answer (see paragraph 1.90) was not strictly relevant to the question about R&D carried out by British industry in the context of which it was given. It introduced the comparison of total R&D - the figures are as in Figure 4 above—rather than industrial R&D, and the statement that the United Kingdom is in the middle of a group consisting of France, West Germany, Italy, Japan and the USA conceals more than it reveals. The relevant comparison, for R&D funded by industry, would be as follows:-



1.101 On this basis, the United Kingdom's performance is below the level of Japan, Germany and the United States again.

1.102 Mr Jackson, in his answer to a debate on British science (see paragraph 1.90), made clear the downward effect of Britain's "relatively low industrial investment in R&D" and also the impact of the United Kingdom's "relatively high commitment to defence". His legitimate conclusion was that "our financial inputs as a proportion of GDP are broadly in line with those of our competitors". The figures above however suggest that the conclusion is not very informative, in that it did not specify which financial inputs were in line with other countries

1.103 What none of these comparisons do is to include a time factor and to take account of changes in GDP. As mentioned above, the OECD have suggested that a better indicator of a country's commitment to R&D is obtained by comparing growth in GERD against growth in GDP. The latest available statistics in this form present a different story—see Figure 6. In this diagram the position of a country in relation to the diagonal line is an indicator of that country's R&D effort. In countries above the diagonal line growth in GERD was greater than growth in GDP and the greater the distance from the diagonal line the greater the country's R&D effort in relation to its available resources. The OECD commented that the "United Kingdom was the only country where growth in R&D expenditure was lower than growth in GDP"¹. Special factors may have influenced the trend but the figures, when presented like this, cast considerable doubt on the opinion that our financial inputs are in line with our competitors and that "no one can say that ... we are markedly under-performing".



¹OECD Science and Technology Indicators, Report No 3, 1989, p.20

CONCLUSION

2.1 If R&D statistics are going to be useful, they have to be based on agreed definitions. The Frascati definitions may not be faultless but they are internationally acceptable. For the purposes of international comparison therefore the United Kingdom should conform to those definitions. All the United Kingdom public sector's definitions of R&D should be standardised around Frascati. The adoption of SSAP13 (revised) means that industry definitions will by degrees meet the same standard. Thus there will be internal, as well as international, standardisation.

2.2 Standard definitions should not however become a straitjacket. They are only a means to an end, and different ends do not require equally sophisticated means. The definitions for international comparison need not be the same as those used for national policy formulation or industrial management, just as long as they are compatible.

2.3 On the whole the fewer the sub-divisions of R&D, the better for comparative purposes. Subjectivity in classification is unavoidable. So extra categories are liable to give an impression of accuracy which is in fact spurious. For this reason the Committee see no reason why international comparisons should use more than two categories, (1) research and (2) development. The Committee would be content to drop the distinctions within "research" for comparisons between the United Kingdom and other countries.

2.4 For the purposes of national policy formulation and therefore for the Annual Review, on the other hand, the research category needs to be sub-divided into "basic" and "applied". To make these sub-divisions more reliable, the problem of "strategic research" must be resolved. The Committee are opposed to the creation of a whole new sub-division of "strategic research", but they regard the concept as important and consider that its location within "basic" or "applied" research should be established firmly. It fits neither category as now defined. The OECD are urged to examine the issue: the outcome may be to allocate strategic research on a case by case basis to one or other category in accordance with agreed guidelines.

2.5 In industry SSAP13 requires no distinction within R&D but disclosure of an aggregate total. As a minimum requirement, at least for the interim, this is a great step forward which the Committee fully endorse. In the longer term, they would prefer to see research identified separately from development and suggest that most companies which engage in significant research programmes would want to make the distinction for their own management purposes.

2.6 As indicated in Appendix 4, the Accounting Standards Committee have chosen to adapt the Frascati definitions slightly in drafting SSAP13, to make them more suitable to industrial accounting. The Select Committee suggest that OECD should look at these adaptations to see whether in the light of them the Frascati definitions could be improved. If a European accounting standard is going to be developed it is desirable that Frascati and the accounting standards should converge as far as possible. In respect of strategic research, however, SSAP13 is unlikely to offer an improvement, because its definitions seem effectively to exclude strategic research from all categories.

2.7 Some refinements of the Annual Review have already been proposed in this report. In general the format meets its purposes well, subject to a satisfactory outcome to the categorisation of strategic research. The more detailed treatment of R&D by both types of activity and also primary purpose and socio-economic activity serves the needs of policy formulation.

2.8 A necessary development now is to reconcile the Annual Review and the DTI's industrial survey. As part of this process, DTI and the Central Statistical Office will have to take the action proposed in paragraph 1.35, particularly to counter the lack of feedback felt by industry.

2.9 The foremost area for improvement is the classification of defence R&D. As stated in paragraph 1.41 above, MoD R&D must be categorised according to the Frascati definitions. Recent practice may suit the internal accounting needs of MoD but it is not acceptable in the context of other public disclosure of R&D. There is no reason why the public and private sectors should have different levels of accuracy. Because of the large scale of defence R&D, misdescriptions of defence R&D unbalance the total.

2.10 Much of what is now classed as defence R&D is not true R&D at all. In order to correct this, the Committee recommend that the National Audit Office, with suitable technical support, should report on MoD's R&D expenditure, identifying how much of the expenditure falls within the Frascati definitions and the provisions of SSAP13.

2.11 The Committee recommend that the practice of quoting combined defence and civil R&D figures in the UK should generally be discontinued. The MoD has made absolutely clear, as the

ACOST report on Defence R&D (in its Appendix G6) records, that its R&D programme is drawn up without any regard for civil spin-off: "The MoD itself points out that its singular duty is to get the best value for money for its armed forces; and that it is not—and should not be—under any additional obligation to find funds for general support of technological inquiry, experimentation with new manufacturing techniques, or pursuit of possible commercial applications of military technologies. It also emphatically does not acknowledge any responsibility for helping safeguard and sustain the national technology base." The ACOST report estimates that the knowledge and technology transfer potential of defence research is not more than 20%. In those circumstances, defence R&D should be recognised for what it is and not lumped together with civil R&D from which, in the United Kingdom, it is largely distinct.

2.12 The principal reason for this recommendation arises from the practice of international comparison. There is little point in attempting to draw useful conclusions from a comparison of the United Kingdom's total Government-funded R&D spend (of which civil R&D is only half) with the Government-funded R&D spend of Japan (of which civil R&D is 96.5%) and Germany (of which civil R&D is 87.3%). The only conclusion to be drawn is a false sense of security.

2.13 The OECD should consider the same change of practice. In relation both to the civil/defence divide and to their international comparisons, they should stress the importance of comparing like with like. Each member country will benefit if the OECD can help them to interpret R&D definitions consistently and correctly.

2.14 Even following the past practice of lumping civil and defence R&D together, the UK's performance in statistical terms is not good—the defence figure of £2.3bn is considerably overstated. But the truer comparison should be between more closely related statistics. None of the available comparisons is without its defects. Perhaps, of the options given in paragraphs 1.82–9 above, the most appropriate gauges of international competitiveness would be total civil R&D (public and private sectors) as a percentage of GDP, and growth in such R&D compared with growth in GDP. On this basis, the place of the United Kingdom in relation to our main competitors is low and declining.

Major Lessons

2.15 The major lesson from this review of definitions of R&D is therefore the disturbing conclusion that, as a nation, we are investing too little in civil R&D and the situation is getting worse. Our national expenditure (particularly in the private sector) is not in line with our competitors.

2.16 A second lesson is that an appreciation of the precise nature of R&D, and its component parts, may lead to a better assessment of R&D and its place in the process of innovation. The Cabinet Office's guide to "R&D Assessment" (see paragraph 1.80 above) hints at the ease with which R&D can be undertaken without a precise idea of its objectives, or how a project or programme, once begun, can continue after its main justification has passed.

2.17 Agreed definitions of R&D and better statistics can help to produce clearer thought and a better appreciation of the true state of R&D in the United Kingdom—at Government and company level. The figures will never be more than a guide. They can be misused easily. But they are still important.

APPENDIX 1

Sub-Committee II (Definitions of R&D)

The members of the Sub-Committee which conducted this enquiry were:

L. Carver (Chairman)
L. Chorley
L. Clitheroe
L. Dainton
L. Erroll of Hale
L. Flowers
L. Gregson
L. Kearton
L. Kirkwood
L. Nelson of Stafford
L. Sherfield

The Specialist Adviser was Professor Roger Williams, Professor of Government and Science Policy at the University of Manchester.

APPENDIX 2

List of Witnesses

The following witnesses gave evidence. Those marked * gave oral evidence. Those marked † were the respondents to the questionnaire given in Appendix 3.

- †Agricultural and Food Research Council
- †*British Aerospace plc
- †Chartered Institute of Certified Accountants
- †Chartered Institute of Management Accountants
- †*Confederation of British Industry
- †Department of Education and Science
- †Department of Employment
- †Department of Energy
- †Department of the Environment
- †Department of Health
- †Department of Social Security
- †Department of Trade and Industry
- †Department of Transport
- †Economic and Social Research Council
- †Fellowship of Engineering
- *Fielding, Sir Colin
- Hartley, Professor K, University of York
- †Health and Safety Commission
- †Home Office
- †Institute of Chartered Accountants of England and Wales
- †Institute of Chartered Accountants of Scotland
- †Medical Research Council
- †Ministry of Agriculture, Fisheries and Food
- †*Ministry of Defence
- †Natural Environment Research Council
- †Northern Ireland Departments
- Organisation for Economic Cooperation and Development
- †Overseas Development Administration
- †Science and Engineering Research Council
- *Science Policy Research Unit
- †Scottish Office
- *Society of British Aerospace Companies
- Stoneman, Dr P, University of Warwick
- †Training Agency
- †Universities Funding Council
- †Welsh Office

APPENDIX 3

Questionnaires

Questionnaires were sent out to Government departments, Research Councils, industrial and accountancy bodies and others identified in Appendix 2. Below are the texts of the various questionnaires. First, the questionnaire to Government departments (excluding MoD) is given and then the variations.

SELECT COMMITTEE ON SCIENCE AND TECHNOLOGY

SUB-COMMITTEE II — DEFINITIONS OF R&D

The Select Committee on Science and Technology have set up a Sub-Committee, under the Chairmanship of Lord Carver, to enquire into *definitions of R&D spending*.

Figures for R&D spending are increasingly used as indicators of industrial and national investment in innovation. They form the basis for science policy making. As a result the Sub-Committee seek to determine:

- (i) the accuracy of UK figures for R&D spending;
- (ii) the reliability of international comparisons of R&D spending.

In order to do this it is necessary to identify exactly what is being defined as R&D. Current definitions, as used in the 'Annual Review of Government Funded R&D' and by the Accounting Standards Committee in SSAP13, are based on the OECD (Frascati) definitions (Annex 1). The enquiry assumes that Frascati will remain the international standard. The Frascati manual is at present being revised and another objective of the enquiry is:

- (iii) to contribute to the OECD's revision of the Frascati definitions.

The Sub-Committee therefore seek to discover how the Frascati definitions are used and understood, whether they form a satisfactory basis for assessing comparative performance, and whether they are applied differently in practice by different countries, industries or organisations.

The Sub-Committee would welcome any comments on the above points and would be grateful if witnesses would also answer the following specific questions in the evidence which they submit:

1. Do you use the Frascati definitions in making returns to the Annual Review of Government Funded R&D? If not what definitions do you use?

2. Do you use the same definitions in your day to day operations, or is it necessary to use other definitions? If so, how do these definitions differ from those used in the Annual Review?

3. Do you experience any difficulty in converting your figures for R&D spending into the format required for the Annual Review? Do you encounter any other problems in making returns to the Annual Review?

4. What explanatory notes or guidelines do you use in interpreting the Frascati definitions? Are they adequate for this purpose? What degree of subjectivity is involved in categorising your R&D spending?

5. Do the Frascati definitions provide a clear means of differentiating between:

- (a) basic and applied research;
- (b) research and development;
- (c) R&D and other related activities;

for the purposes, in each case, of:

- (i) compiling statistics of your R&D spending;
- (ii) compiling R&D statistics within a scientific and/or industrial sector;
- (iii) comparing R&D activity between different scientific and industrial sectors;
- (iv) making international comparisons of R&D activity?

6. What are the specific inadequacies of the Frascati definitions, and how might they be amended? For example, the OECD is considering supplementing the 'basic' and 'applied' research categories with a 'strategic' research category? The United States Department of Defense sub-divides 'experimental development' into 'exploratory', 'advanced' and 'engineering' development (Annex 2). Would there be any advantage in using these, or other, categories to classify R&D spending?

7. Would you give specific examples of the work funded by your department in 1986-87 which was recorded under each of the headings in Table 1.22 of the 1988 'Annual Review of Government Funded R&D', i.e.:

- (a) basic;

- (b) applied — strategic;
- (c) applied — specific;
- (d) experimental development.

8. Did any of the work funded by you in 1986-87 fall outside the Frascati definition of R&D, but within the range of related activities which you have difficulty in distinguishing from R&D? If so, would you provide specific examples of those activities with which you had difficulty. Was the spending on these activities included in Table 1.22? If not where was it reported?

9. The Annual Review of Government Funded R&D also classifies R&D spending according to 'primary purpose'. How does this classification differ from Frascati? What advantages, if any, does this classification have over Frascati?

10. In the Annual Review of Government Funded R&D there is an 'apparent discrepancy' between the amount that government says it spends on R&D in industry and what industry says it receives from government. How does this situation arise and how can it be improved?

11. It has been suggested that the number of scientifically and technically qualified personnel employed on R&D is a better indicator of R&D effort than is the figure for R&D spending. Do you agree?

ANNEX 1

The Frascati Definitions of R&D

In 'The Measurement of Scientific and Technical Activities: The Frascati Manual 1980', OECD, Paris, 1981, research and experimental development (R&D) is defined as:

"creative work undertaken on a systematic basis in order to increase the stock of knowledge, including knowledge of man, culture and society and the use of this stock of knowledge to devise new applications".

The Frascati manual divides R&D into three general categories;

- (1) basic research
- (2) applied research
- (3) experimental development.

1. *Basic Research* is defined as "experimental or theoretical work undertaken primarily to acquire new knowledge of the underlying foundation of phenomena and observable facts, without any particular application or use in view".

2. *Applied Research* is defined as "original investigation undertaken in order to acquire new knowledge but is directed primarily towards a specific practical aim or objective".

3. *Experimental Development* is defined as "systematic work, drawing on existing knowledge gained from research or practical experience that is directed to produce new materials, products or devices, to installing new processes, systems and services, or to improve those already produced".

Frascati states that "the basic criterion for distinguishing R&D from related activities is the presence in R&D of an appreciable element of novelty".

ANNEX 2

R&D Definitions Used by the US Department of Defense

The US Department of Defense does not routinely use the Frascati categories of "basic research", "applied research" and "development" in its budgeting and program management, but instead disaggregates research, development, test and evaluation (RDT&E) (i) by budgetary activity, and (ii) by functional classification.

In the present context it is the latter, functional classification, which is of interest. This uses a number of categories to identify the "phase or stage" of an activity in the RDT&E process or cycle:

- (1) Research;
- (2) Exploratory Development;
- (3) Advanced Development;
- (4) Engineering Development;
- (5) Management and Support.

These categories are defined as follows:

1. *Research*: Includes scientific study and experimentation directed toward increasing knowledge and understanding in those fields of the physical, engineering, environmental, biological-medical, and behavioural-social sciences related to long-term national security needs. It provides fundamental knowledge for the solution of identified military problems. It also provides part of the base for subsequent exploratory and advanced developments in the defense-related technologies and of new or improved military functional capabilities in areas such as communications, detection, tracking surveillance, propulsion, mobility, guidance and control, navigation, energy conversion, materials and structures, and personnel support.

2. *Exploratory Development*: Includes all effort directed toward the solution of specific military problems, short of major development projects. This type of effort may vary from fairly fundamental applied research to quite sophisticated breadboard hardware, study programming and planning effort. It would thus include studies, investigations and minor development effort. The dominant characteristic of this category of effort is that it be pointed toward specific military problem areas with a view toward developing and evaluating the feasibility and practicability of proposed solutions and determining their parameters.

3. *Advanced Development*: Includes all projects which have moved into the development of hardware for experimental or operational test. It is characterized by line item projects, and program control is exercised on a project basis. A further descriptive characteristic lies in the design of such items being directed toward hardware for test or experimentation as opposed to items designed and engineered for eventual Service use.

4. *Engineering Development*: Includes all those development programs being engineered for Service use but which have not yet been approved for procurement or operation. This area is characterised by major line item projects and program control by review of individual projects.

5. *Management and Support*: Includes research and development effort directed toward support of installations or operations required for general research and development use. Included would be test ranges, military construction, maintenance support of laboratories, operations and maintenance of test aircraft and ships, and studies and analyses in support of laboratories, operations and maintenance of test aircraft and ships, and studies and analyses in support of the R&D program. Costs of laboratory personnel, either in-house or contract-operated, would be assigned to appropriate projects or as a line item in the Research, Exploratory Development, or Advanced Development Program areas, as appropriate. Military Construction costs directly related to a major development program will be included in the appropriate element.

Other Questionnaires

Other witnesses received letters of invitation similar to that sent to the Government departments, but which contained some differences, particularly with respect to the questions asked. The questionnaires themselves are reproduced below:

RESEARCH COUNCILS AND THE UNIVERSITIES FUNDING COUNCIL

1. Do you use the Frascati definitions in making returns to the "Annual Review of Government Funded R&D? If not what definitions do you use?

2. Do you use the same definitions in your day to day operations, or is it necessary to use other definitions? If so, how do these definitions differ from those used in the Annual Review?

3. Do you experience any difficulty in converting your figures for R&D spending into the format required for the Annual Review? Do you encounter any other problems in making returns to the Annual Review?

4. What explanatory notes or guidelines do you use in interpreting the Frascati definitions? Are they adequate for this purpose? What degree of subjectivity is involved in categorising your R&D spending?

5. Do the Frascati definitions provide a clear means of differentiating between:

- (a) basic and applied research;
- (b) research and development;
- (c) R&D and other related activities;

for the purposes, in each case, of:

- (i) compiling statistics of your R&D spending;
 - (ii) compiling R&D statistics within a scientific and/or industrial sector;
 - (iii) comparing R&D activity between different scientific and industrial sectors;
 - (iv) making international comparisons of R&D activity?
6. What are the specific inadequacies of the Frascati definitions, and how might they be amended? For example, the OECD is considering supplementing the 'basic' and 'applied' research categories with a 'strategic' research category?
7. Would you give specific examples of the work funded by your Council in 1986-87 which was recorded under each of the headings in Table 1.22 of the 1988 'Annual Review of Government Funded R&D', i.e.:
- (a) basic;
 - (b) applied—strategic;
 - (c) applied—specific;
 - (d) experimental development.
8. Did any of the work funded by you in 1986-87 fall outside the Frascati definition of R&D, but within the range of related activities which you have difficulty in distinguishing from R&D? If so, would you provide specific examples of those activities with which you had difficulty. Was the spending on these activities included in Table 1.22? If not where was it reported?
9. It has been suggested that the number of scientifically and technically qualified personnel employed on R&D is a better indicator of R&D effort than is the figure for R&D spending. Do you agree?

MINISTRY OF DEFENCE (MoD)

- 1. Do you use the Frascati definitions in making returns to the 'Annual Review of Government Funded R&D'? If not what definitions do you use?
- 2. Do you use the same definitions in your day-to-day operations, or is it necessary to use other definitions? If so how do these definitions differ from those used in the Annual Review?
- 3. Do you experience any difficulty in converting your figures for R&D spending into the format required for the Annual Review? Do you encounter any other problems in making returns to the Annual Review?
- 4. What explanatory notes or guidelines do you use in interpreting the Frascati definitions? Are they adequate for this purpose?
- 5. It has been suggested to the Sub-Committee that many of the tasks involved in major MoD development contracts do not contain the "appreciable element of novelty" which is at the heart of the Frascati philosophy. What is your understanding of an "appreciable element of novelty"?
- 6. What degree of subjectivity is involved in categorizing your R&D spending? Is it possible to attach confidence limits to your figures for R&D spending (ie. $\pm 5\%$, 10% or 20%)?
- 7. Do the Frascati definitions provide a clear means of differentiating between:
 - (a) basic and applied research;
 - (b) research and development;
 - (c) R&D and other related activities;
 for the purposes, in each case, of:
 - (i) compiling statistics of the MoD's intramural R&D expenditure;
 - (ii) compiling statistics of the MoD's extramural R&D expenditure;
 - (iii) compiling R&D statistics within a scientific and/or industrial sector;
 - (iv) comparing R&D activity between the civil and defence sectors;
 - (v) making international comparisons of R&D activity?
- 8. What are the specific inadequacies of the Frascati definitions, and how might they be amended? For example the US Department of Defense sub-divides experimental development into 'exploratory', 'advanced' and 'engineering' development (Annex 2). Would there be any advantages in the use of these, or other, categories to classify your own development expenditure?

9. Would you give specific examples of the work funded by the MoD in 1986-87 which was recorded under each of the headings in Table 1.22 of the 1988 'Annual Review of Government Funded R&D', ie:

- (a) applied — strategic research;
- (b) applied — specific research;
- (c) experimental development.

10. Did any of the work funded by you in 1986-87 fall outside the Frascati definition of R&D, but within the range of related activities which you have difficulty in distinguishing from R&D? If so would you provide specific examples of those activities with which you had difficulty. Was this spending included in Table 1.22? If not where was it reported?

11. The 'Annual Review of Government R&D' also classifies R&D spending according to 'primary purpose'. How does this classification differ from Frascati? What advantages, if any, does this classification have over Frascati?

12. In the 'Annual Review of Government Funded R&D' there is an "apparent discrepancy" between the amount that government says it spends on R&D in industry and what industry says it receives from government. How does this situation arise and how can it be improved?

13. It has been suggested that the number of scientifically and technically qualified personnel employed in R&D is a better indicator of R&D effort than is the figure for R&D spending. Do you agree?

CABINET OFFICE/DEPARTMENT OF TRADE AND INDUSTRY (DTI) (as collators of UK R&D statistics)

1. Are the Frascati definitions used by the following for the purpose of making returns to the 'Annual Review of Government Funded R&D':

- (a) civil government departments;
- (b) the MoD;
- (c) the Research Councils and the UFC;
- (d) industry (via the DTI survey of Industrial R&D)?

If not, what definitions do they use?

2. Are you aware of any differences between the Frascati definitions and the definitions used by the above organisations in their day-to-day operations?

3. Do respondents to the Annual Review/DTI survey experience any difficulty in converting their figures for R&D spending, into the format required for the Annual Review/DTI survey? Are you aware of any other problems that respondents have in making returns to the Annual Review/DTI survey?

4. What supporting explanatory notes and/or guidelines do you provide in order to ensure a consistent interpretation of the Frascati definitions? Are they adequate for this purpose? How well do respondents to the Annual Review/DTI survey understand the concept of an "appreciable element of novelty", which is at the heart of the Frascati definitions?

5. What is the accuracy of returns to the Annual Review/DTI survey? What degree of subjectivity is involved when respondents categorize their R&D spending according to the Frascati definitions? Is it possible to attach confidence limits to these figures, i.e. $\pm 5\%$, or $\pm 10\%$ or $\pm 20\%$? How reliable are apparent trends from a particular source?

6. What factors limit the accuracy of the R&D statistics? For example, it has been suggested to the Sub-Committee that the accuracy of industrial R&D statistics is affected by the failure to record the R&D activities of small firms?

7. Do the Frascati definitions provide a consistent means of differentiating between:

- (a) different basic and applied research;
- (b) research and development;
- (c) R&D and other activities;

for the purposes, in each case, of:

- (i) compiling statistics of R&D activity within a scientific or industrial sector;

- (ii) compiling R&D statistics across the whole of the UK economy;
- (iii) comparing R&D activity between the private and public sectors (civil);
- (iv) comparing R&D activity between the private and public sectors (defence);
- (v) making international comparisons of R&D activity;

8. What are the specific inadequacies of the Frascati definitions, and how might they be amended? For example the OECD is considering supplementing the categories of 'basic' and 'applied' research with a 'strategic' research category. The US Department of Defense sub-divides 'experimental development' into 'exploratory', 'advanced' and 'engineering' development (Annex 2). Would Frascati be improved by the use of these categories? Would there be any advantages in the use of these, or other, categories to classify R&D spending in the Annual Review/DTI survey?

9. In the 'Annual Review of Government Funded R&D' there is an "apparent discrepancy" between the amount that government says it spends on R&D in industry and what industry says it receives from government. How does this situation arise and how can it be improved?

10. In view of the "apparent discrepancy" mentioned above and the fact that the information contained in Table 1.3 of the Annual Review is "not directly comparable" with other information in the Annual Review, are the figures for R&D spending a reliable basis for science policy making in the UK?

11. In the Annual Review R&D spending is also classified according to "primary purpose". What is the purpose of this classification and how does it differ from Frascati? Does it have any advantage over Frascati? What emphasis do/should users of R&D statistics place on the different methods of classification?

12. It has been suggested that the number of scientifically and technically qualified personnel employed in R&D is a better indicator of R&D effort than is the figure for R&D spending. Do you agree?

13. In what ways could the 'Annual Review of Government Funded R&D' be improved? For example, several other countries include effectiveness measures (i.e. output indicators) in their reviews of R&D spending.

14. It has been suggested that the main problem with the UK R&D statistics lies not in their quality but in the lack of resources devoted to their collection. Do you agree? What impact will the reorganisation of the Central Statistical Office have on the collection and presentation of UK R&D statistics?

CONFEDERATION OF BRITISH INDUSTRY (CBI)

1. What definitions of R&D do companies use in their day-to-day operation? How do these differ from those used for the purpose of:

- (a) making returns to the DTI survey of industrial R&D;
- (b) compiling Annual Reports and Accounts?

2. What problems do companies experience in classifying their R&D spending for the purpose of:

- (a) making returns to the DTI survey of industrial R&D;
- (b) compiling Annual Reports and Accounts?

3. In your initial response to the Sub-Committee you stated that companies "vary in their degree of adherence to the Frascati definitions... while believing their variants are consistent with Frascati". What is the degree of variability between the operating definitions of R&D used by companies within:

- (a) the same industrial sector;
- (b) different industrial sectors?

4. What explanatory notes or guidelines do companies use in interpreting the Frascati definitions? Are they adequate for this purpose? How well do companies understand the concept of an "appreciable element of novelty", which is at the heart of the Frascati definitions?

5. How good are existing industrial R&D statistics? What degree of subjectivity is involved when companies categorize their R&D spending? Is it possible to attach confidence limits to these figures,

ie. \pm 5%, 10% or 20%? How reliable are apparent trends in the returns from a particular source?

6. What factors limit the accuracy of R&D statistics? For example, it has been suggested to the Sub-Committee that the accuracy of industrial R&D statistics is affected by the failure to record the R&D activities of small firms? Are there any changes to the DTI survey of industrial R&D which you would recommend?

7. Do the Frascati definitions provide a clear means of differentiating between:

- (a) basic and applied research;
- (b) research and development;
- (c) R&D and other related activities;

for the purposes, in each case, of:

- (i) compiling statistics of R&D activity within an industrial sector;
- (ii) comparing R&D activity between different industrial and scientific sectors;
- (iii) comparing R&D activity between the private and public sectors (civil);
- (iv) comparing R&D activity between the private and public sectors (defence);
- (v) making international comparisons of R&D activity;

8. In your initial response to the Sub-Committee you stated that “fair comparison based on Frascati ought to be possible provided that a consistent approach was taken”. Does this imply that the Frascati definitions are not consistently applied? If so how can this be improved? What will be the effect of the revision of SSAP13 on this situation?

9. What are the specific inadequacies of the Frascati definitions, and how might they be amended? For example, the OECD is considering supplementing the ‘basic’ and ‘applied’ research categories with a ‘strategic’ research category. The US Department of Defence sub-divides ‘experimental development’ into ‘exploratory’, ‘advanced’ and ‘engineering development’ (Annex 2). Does industry perceive any advantages in the use of these, or other, categories to classify their R&D spending?

10. Taking, as examples, one or more companies from a number of different industrial sectors would you identify the activities, funded by those companies, which they would define as falling:

- (a) within the Frascati definitions of (i) basic research, (ii) applied research, and (iii) experimental development;
- (b) outside the Frascati definitions of R&D, but within the range of related activities which they may have difficulty in distinguishing from R&D.

For each company the activities chosen should relate to the development of a single product or process.

11. In the ‘Annual Review of Government Funded R&D’ there is an “apparent discrepancy” between the amount that government says it spends on R&D in industry and what industry says it receives from government. How does this situation arise and how can it be improved?

12. It has been suggested that the number of scientifically and technically qualified personnel employed in R&D is a better indicator of R&D effort than is R&D spending. Do you agree?

FELLOWSHIP OF ENGINEERING (FEng)

1. In your initial response to the Sub-Committee the Fellowship stated that “the Frascati definitions are generally acknowledged as the foundation upon which Fellows build their own definitions . . . however, the Fellowship has little evidence to suggest that the Frascati definitions in their original form are currently being used”. What operating definitions of R&D are used by the organisations with which your Fellows are associated? What is the degree of variability between the operating definitions used by organisations:

- (a) within the same industrial and/or scientific sector;
- (b) in different industrial and/or scientific sectors?

2. In making returns to the DTI Industrial Survey companies are required to classify their R&D spending according to the Frascati definitions. What problems do the organisations, with which your Fellows are associated, experience in making their returns?

3. What explanatory notes or guidelines do the organisations, with which your Fellows are associated, use in interpreting the Frascati definitions? Are they adequate for this purpose? How well do these organisations understand the concept of an “appreciable element of novelty” which is at the heart of the Frascati definitions?

4. How good are existing UK R&D statistics? What degree of subjectivity is involved when organisations, with which your Fellows are associated, categorize their R&D spending? Would it be possible to attach confidence limits to these figures, ie. $\pm 5\%$, 10% or 20% ? How reliable are apparent trends in the returns from a particular source?

5. What factors limit the accuracy of R&D statistics? For example, it has been suggested to the Sub-Committee that the accuracy of industrial R&D statistics is affected by the failure to record the R&D activities of small firms. Are there changes to the DTI survey of industrial R&D which you would recommend?

6. Do the Frascati definitions provide a clear means of differentiating between:

- (a) basic and applied research;
- (b) research and development;
- (c) R&D and other related activities;

for the purposes, in each case, of:

- (i) compiling statistics of R&D activity within a scientific and/or industrial sector;
- (ii) comparing R&D activity between different industrial and scientific sectors;
- (iii) comparing R&D activity between the private and public sectors (civil);
- (iv) comparing R&D activity between the private and public sectors (defence);
- (v) making international comparisons of R&D activity;

7. In your initial response to the Sub-Committee you stated that that the Frascati definitions “are satisfactory for differentiating between basic and applied research on the one hand and other activities” ... adding that “there is a need to refine the definition of ‘experimental development’ so that the cut-off points between research, design and development and production are clearly established”. How might the existing definitions be amended to achieve this? The US Department of Defense, for example, sub-divides ‘experimental development’ into ‘exploratory’, ‘advanced’ and ‘engineering development’ (Annex 2). Also the OECD is considering supplementing the categories of ‘basic’ and ‘applied’ research with a ‘strategic’ research category. Would there be any advantages in the use of these, or other, categories to classify R&D spending?

8. Taking, as examples, one or more organisations, with which your Fellows are associated, from a number of different scientific and industrial sectors, would you identify the activities, funded by those organisations, which they would define as falling:

- (a) within the Frascati definition of (i) basic research, (ii) applied research, and (iii) experimental development;
- (b) outside the Frascati definition of R&D, but within the range of related activities which they may have difficulty in distinguishing from R&D.

For each organisation the activities chosen should, where possible, relate to the development of a single product or process.

9. In the ‘Annual Review of Government Funded R&D’ there is an “apparent discrepancy” between the amounts that government says it spends on R&D in industry and what industry says it receives from government. How does this situation arise and how can it be improved?

10. It has been suggested that the number of scientifically and technically qualified personnel employed in R&D is a better indicator of R&D effort than is the figure for R&D spending. Do you agree?

ACCOUNTING BODIES

1. From your experiences of compiling company accounts, before the recent revision of SSAP13, how widely used were the Frascati definitions of R&D? What degree of variability existed in the use and understanding of the Frascati definitions? What effect will the revision of SSAP13 have on this variability?

2. Are there any differences between the definitions of R&D used by companies in their day to day operations and those used in SSAP13 (revised)? If so do companies experience any difficulty in converting their R&D spending from one set of definitions to the other?

3. What explanatory notes or guidelines do companies use in interpreting definitions of R&D spending for the purpose of compiling company accounts? Are they adequate for this purpose? What degree of subjectivity is involved in identifying R&D costs for the purpose of compiling company accounts?

4. Do the Frascati definitions provide a clear means of differentiating between:

- (a) basic and applied research;
- (b) research and development;
- (c) R&D and other related activities;

for the purpose of identifying those costs which should be included as R&D spending in company accounts?

5. What are the specific inadequacies of the Frascati definitions, and how might they be amended? For example it has been suggested that:

- (a) the Frascati definitions are difficult to apply in areas which are not scientific and technological, thereby excluding the saleable products of creative effort in other areas;
- (b) there is a large amount of government contract work, particularly in the defence sector, which is not adequately accounted for in company Annual Report and Accounts?

6. In view of the difficulties encountered in classifying R&D costs it has been suggested that a better indicator of a company's commitment to R&D would be the number of scientifically and technically qualified personnel employed rather than the money spent on R&D. Do you agree?

APPENDIX 4

SSAP13 and Frascati

In this Appendix the Committee reproduce the text of Statement of Standard Accounting Practice No. 13 (SSAP13) revised, and then compare the Frascati and SSAP13 definitions of R&D.

Statement of Standard Accounting Practice No. 13*Accounting for research and development*

(Issued December 1977, revised January 1989)

The provisions of this statement of standard accounting practice should be read in conjunction with the Explanatory foreword to accounting standards and need not be applied to immaterial items.

Part 1 — Explanatory Note**Basic concepts**

1. The accounting policies to be followed in respect of research and development expenditure must have regard to the fundamental accounting concepts including the 'accruals' concept by which revenue and costs are accrued, matched and dealt within the period to which they relate and the 'prudence' concept by which revenue and profits are not anticipated but are recognised only when realised in the form either of cash or of other assets the ultimate cash realisation of which can be established with reasonable certainty. It is a corollary of the prudence concept that expenditure should be written off in the period in which it arises unless its relationship to the revenue of a future period can be established with reasonable certainty.

The different types of research and development expenditure

2. The term 'research and development' is currently used to cover a wide range of activities, including those in the services sector. The definitions of the different types of research and development used in this statement are based on those used by the Organisation for Economic Co-operation and Development for the purposes of collecting data world-wide.

3. Classification of expenditure is often dependent on the type of business and its organisation. However, it is generally possible to recognise three broad categories of activity, namely pure research, applied research and development. The definitions of the individual categories are set out in Part 2.

4. The dividing line between these categories of expenditure is often indistinct and particular expenditure may have characteristics of more than one category. This is especially so when new products or services are developed through research and development to production, when the activities may have characteristics of both development and production.

5. Research and development activity is distinguished from non-research based activity by the presence or absence of an appreciable element of innovation. If the activity departs from routine and breaks new ground it should normally be included; if it follows an established pattern it should normally be excluded.

6. Examples of activities that would normally be included in research and development are:

- (a) experimental, theoretical or other work aimed at the discovery of new knowledge, or the advancement of existing knowledge;
- (b) searching for applications of that knowledge;
- (c) formulation and design of possible applications for such work;
- (d) testing in search for, or evaluation of, product, service or process alternatives;
- (e) design, construction and testing of pre-production prototypes and models and development batches;
- (f) design of products, services, processes or systems involving new technology or substantially improving those already produced or installed;
- (g) construction and operation of pilot plants.

7. Examples of activities that would normally be excluded from research and development include:

- (a) testing and analysis either of equipment or product for purposes of quality or quantity control;
- (b) periodic alterations to existing products, services or processes even though these may represent some improvement;
- (c) operational research not tied to a specific research and development activity;
- (d) cost of corrective action in connection with break-downs during commercial production;
- (e) legal and administrative work in connection with patent applications, records and litigation and the sale or licensing of patents;
- (f) activity, including design and construction engineering, relating to the construction, relocation, rearrangement or start-up of facilities or equipment other than facilities or equipment whose sole use is for a particular research and development project;
- (g) market research.

The accounting treatment of research and development

8. Expenditure incurred on pure and applied research can be regarded as part of a continuing operation required to maintain a company's business and its competitive position. In general, no one particular period rather than any other will be expected to benefit and therefore it is appropriate that these costs should be written off as they are incurred. Expenditure on pure or applied research may not be treated as an asset (Companies Act 1985, Schedule 4, paragraph 3(2)(c)).

9. The development of new products or services is, however, distinguishable from pure and applied research. Expenditure on such development is normally undertaken with a reasonable expectation of specific commercial success and of future benefits arising from the work, either from increased revenue and related profits or from reduced costs. On these grounds it may be argued that such expenditure, to the extent that it is recoverable, should be deferred to be matched against the future revenue.

10. It will only be practicable to evaluate the potential future benefits of development expenditure if:

- (a) there is a clearly defined project; and
- (b) the related expenditure is separately identifiable.

11. The outcome of such a project would then need to be examined for:

- (a) its technical feasibility; and
- (b) its ultimate commercial viability considered in the light of factors such as:
 - (i) likely market conditions (including competing products or services);
 - (ii) public opinion;
 - (iii) consumer and environmental legislation.

12. Furthermore a project will be of value:

- (a) only if further development costs to be incurred on the same project, together with related production, selling and administration costs, will be more than covered by related revenues; and
- (b) adequate resources exist, or are reasonably expected to be available, to enable the project to be completed and to provide any consequential increases in working capital.

13. The elements of uncertainty inherent in the considerations set out in paragraphs 11 and 12 are considerable. There will be a need for different persons with different types of judgement to be involved in assessing the technical, commercial and financial viability of the project. Combinations of the possible differing assessments which they might validly make can produce different assessments of the existence and amounts of future benefits.

14. If these uncertainties are viewed in the context of the concept of prudence, the future benefits of most development projects would be too uncertain to justify carrying the expenditure forward. Nevertheless, in certain industries it is considered that there are a number of major development projects that satisfy the stringent criteria set out in paragraphs 10 to 12. Accordingly, when the expenditure on development projects is judged on a prudent view of available evidence to satisfy these criteria, it may be carried forward and amortised over the period expected to benefit.

15. At each accounting date the unamortised balance of development expenditure should be examined project by project to ensure that it still fulfils the criteria in paragraphs 10 to 12. Where any doubt exists as to the continuation of those circumstances the balance should be written off.

16. Fixed assets may be acquired or constructed in order to provide facilities for research and/or development activities. The use of such fixed assets usually extends over a number of accounting periods and accordingly they should be capitalised and written off over their useful life. The depreciation so written off should be included as part of the expenditure on research and development and disclosed in accordance with SSAP12.

Exceptions

17. Where companies enter into a firm contract:

- (a) to carry out development work on behalf of third parties on such terms that the related expenditure is to be fully reimbursed, or
- (b) to develop and manufacture at an agreed price calculated to reimburse expenditure on development as well as on manufacture,

any such expenditure which has not been reimbursed at the balance sheet date should be dealt with as contract work-in-progress.

18. Expenditure incurred in locating and exploiting oil, gas and mineral deposits in the extractive industries does not fall within the definition of research and development used in this accounting standard. Development of new surveying methods and techniques as an integral part of research on geological phenomena should, however, be included in research and development.

Disclosure

19. While there are uncertainties inherent in research and development projects, such activities are important in forming a view of a company's future prospects. Detailed disclosure raises considerable problems of definition and the disclosure requirements of this standard are therefore limited to:

- (a) accounting policy as required by SSAP2;
- (b) disclosure of the total amount of research and development expenditure charged in the profit and loss account, distinguishing between the current year's expenditure and amounts amortised from deferred expenditure;
- (c) the movements on deferred development expenditure during the year.

20. Having regard to the problems of definition and disclosure referred to above, the scope of disclosure required under paragraph 19(b) is (except in the case of Republic of Ireland companies) restricted in effect to companies which are public limited companies, or special category companies, or subsidiaries of such companies, or which exceed by a multiple of 10 the criteria for defining a medium-sized company under the Companies Act 1985.

Part 2—Definition of Terms

21. The following definition is used for the purpose of this statement:

Research and development expenditure means expenditure falling into one or more of the following broad categories (except to the extent that it relates to locating or exploiting oil, gas or mineral deposits or is reimbursable by third parties either directly or under the terms of a firm contract to develop and manufacture at an agreed price calculated to reimburse both elements of expenditure):

- (a) pure (or basic) research: experimental or theoretical work undertaken primarily to acquire new scientific or technical knowledge for its own sake rather than directed towards any specific aim or application;
- (b) applied research: original or critical investigation undertaken in order to gain new scientific or technical knowledge and directed towards a specific practical aim or objective;
- (c) development: use of scientific or technical knowledge in order to produce new or substantially improved materials, devices, products or services, to install new processes or systems prior to the commencement of commercial production or commercial applications, or to improving substantially those already produced or installed.

Part 3—Standard Accounting Practice

Scope

22. This standard applies to all financial statements intended to give a true and fair view of the financial position and profit or loss, but, except in the case of Republic of Ireland companies (see paragraphs 45 and 46), the provisions set out in paragraph 31 regarding the disclosure of the total amounts of research and development charged in the profit and loss account need not be applied by an entity that:

- (a) is not a public limited company or a special category company (as defined by section 257 of the Companies Act 1985)* or a holding company that has a public limited company or a special category company as a subsidiary; and
- (b) satisfies the criteria, multiplied in each case by 10, for defining a medium-sized company under section 248 of the Companies Act 1985, as amended from time to time by statutory instrument and applied in accordance with the provisions of section 249 of the Act.†

Accounting treatment

23. The cost of fixed assets acquired or constructed in order to provide facilities for research and development activities over a number of accounting periods should be capitalised and written off over their useful lives through the profit and loss account.

24. Expenditure on pure and applied research (other than that referred to in paragraph 23) should be written off in the year of expenditure through the profit and loss account.

25. Development expenditure should be written off in the year of expenditure except in the following circumstances when it may be deferred to future periods:

- (a) there is a clearly defined project, and
- (b) the related expenditure is separately identifiable, and
- (c) the outcome of such a project has been assessed with reasonable certainty as to:
 - (i) its technical feasibility, and
 - (ii) its ultimate commercial viability considered in the light of factors such as likely market conditions (including competing products), public opinion, consumer and environmental legislation, and
- (d) the aggregate of the deferred development costs, any further development costs, and related production, selling and administration costs is reasonably expected to be exceeded by related future sales or other revenues, and
- (e) adequate resources exist, or are reasonably expected to be available, to enable the project to be completed and to provide any consequential increases in working capital.

26. In the foregoing circumstances development expenditure may be deferred to the extent that its recovery can reasonably be regarded as assured.

27. If an accounting policy of deferral of development expenditure is adopted, it should be applied to all development projects that meet the criteria in paragraph 25.

28. If development costs are deferred to future periods, they should be amortised. The amortisation should commence with the commercial production or application of the product, service, process or system and should be allocated on a systematic basis to each accounting period, by reference to either the sale or use of the product, service, process or system or the period over which these are expected to be sold or used.

*There is no exact equivalent of 'special category companies' in the Republic of Ireland. The Sixth Schedule to the 1963 Act refers to 'special classes of company' which include banking, discount and assurance companies but not shipping companies.

†Equivalent legal references

Great Britain
Companies Act 1985
Section 248
Section 249
Section 257

Northern Ireland
Companies (Northern Ireland) Order 1986
Article 256 (as amended)
Article 257
Article 265

Republic of Ireland
Companies (Amendment) Act 1986
Section 8
Section 9
Companies Act 1963
Sixth Schedule, paragraph 23

29. Deferred development expenditure for each project should be reviewed at the end of each accounting period and where the circumstances which have justified the deferral of the expenditure (paragraph 25) no longer apply, or are considered doubtful, the expenditure, to the extent to which it is considered to be irrecoverable, should be written off immediately project by project.

Disclosure

30. The accounting policy on research and development expenditure should be stated and explained.

31. The total amount of research and development expenditure charged in the profit and loss account should be disclosed, analysed between the current year's expenditure and amounts amortised from deferred expenditure.

32. Movements on deferred development expenditure and the amount carried forward at the beginning and the end of the period should be disclosed. Deferred development expenditure should be disclosed under intangible fixed assets in the balance sheet.

Date from which effective

33. The accounting and disclosure requirements set out in this statement should be adopted as soon as possible and regarded as standard in respect of financial statements relating to accounting periods beginning on or after 1 January 1989.

Comparison of the Frascati and SSAP13 Definitions of R&D

The SSAP13 definitions of the different types of research and development are based on those described in the OECD Frascati Manual, and used by the OECD for the purpose of collecting data worldwide.

In formulating SSAP13 the Accounting Standards Committee found it necessary to make some slight modifications to the wording of the Frascati definitions (outlined below). In this respect it is worth noting that:

1. the Frascati Manual was written by and for the national experts in member countries who collect and issue national R&D data and who submit responses to OECD biennial R&D surveys (para 1);
2. one of the main aims of the manual is to establish specifications for R&D input data which can be collected from a wide range of performers (i.e. not just industry) and which can also be aggregated to give meaningful national totals (para 28);
3. although the maximum use is made of examples from Chapter 2 onwards, the OECD recognise that the Manual is still a "rather technical document" and as such is intended "mainly as a reference work";
4. the OECD recognise that "operational criteria must be developed which are suitable for the sector being surveyed". Thus they suggest that "on questionnaires intended for the Business Enterprise sector it would be appropriate to give guidance for distinguishing between R&D and pre-production. . ." (para 255);
5. the OECD recognise that during R&D surveys respondents may have great practical difficulty in applying the theoretical distinctions described in the Frascati Manual to the wide range of projects in progress in their organisation. As surveying agencies are not always in a position to check the responses they receive and are usually obliged to accept them as given, it is of utmost importance that they provide the institutions surveyed with the maximum of explanation and guidance to complement the formal definitions and to ensure uniformity (para 256). The OECD notes (para 257) that four important tools are available to achieve this:
 - (a) explanatory notes;
 - (b) hypothetical examples;
 - (c) guidance to individual respondents;
 - (d) documentation on treatment of different cases.

DEFINITIONS OF R & D

FRASCATI

SSAP13

Basic Research

Experimental or theoretical work undertaken primarily to acquire new knowledge of the underlying foundations of phenomena and observable facts, without any particular application or use in view.

Pure (or basic) Research

Experimental work undertaken primarily to acquire new scientific or technical knowledge for its own sake rather than directed towards any specific aim or application.

Applied Research

Original investigation undertaken in order to acquire new knowledge and directed primarily towards a specific practical aim or objective.

Applied Research

Original or critical investigation undertaken in order to gain new scientific or technical knowledge and directed towards a specific practical aim or objective.

Experimental Development

Systematic work, drawing on existing knowledge gained from research and practical experience, that is directed to producing new materials, products and devices, to installing new processes, systems and services, and to improving those already produced or installed.

Development

Use of scientific or technical knowledge in order to produce new or substantially improved materials, devices, products or services, to install new processes or systems prior to the commencement of commercial applications, or to improving substantially those already produced or installed.

The main aim of SSAP13 would appear to be the clarification of the Frascati definitions in order to make them more suitable for use in the measurement of industrial R & D expenditures. Thus SSAP13 describes:

1. **Basic Research** as 'experimental' rather than 'experimental and theoretical' work; which is undertaken to acquire 'new scientific or technical knowledge' rather than 'new knowledge of the underlying foundations of phenomena and observable facts'. SSAP13 stresses the fact that such work is undertaken 'for its own sake rather than directed towards any specific aim or application'. SSAP13 also describes the category as Pure (or basic) research.
2. **Applied Research** as 'original or critical' rather than simply 'original' investigation; which is undertaken in order to 'gain new scientific or technical knowledge' rather than just 'new knowledge'.
3. **Experimental Development** as the 'use of scientific and technical knowledge in order to produce new or substantially improved materials...prior to the commencement of commercial applications' rather than 'systematic work drawing on existing knowledge'. SSAP13 describes the category as 'Development'.

Significantly improvements to existing products, processes or systems must be 'substantial' in order for the work to be classified as R&D (discussed further below).

DIFFERENTIATION BETWEEN R&D AND CLOSELY RELATED ACTIVITIES

SSAP13 states that the 'R&D activity is distinguished from non-research based activity by the presence or absence of an appreciable element of innovation', in contrast to Frascati which requires 'an appreciable element of novelty'. SSAP13 also adds a qualifying statement that 'if the activity departs from routine and breaks new ground it should be included [as R&D], if it follows an established pattern it should normally be excluded'.

SSAP13 then goes on to provide examples of the types of activity that would normally be included in or excluded from R&D (SSAP13 paras 6-7). Although most of these examples have their origin in the Frascati manual it is significant that the list of examples in SSAP13 are much more concise and to the point (see below).

Activities Normally Included In R&D

SSAP13:

Examples of activities that would normally be included in research and development are:

- (a) experimental, theoretical or other work aimed at the discovery of new knowledge, or the advancement of existing knowledge;
- (b) searching for applications of that knowledge;
- (c) formulation and design of possible applications for such work;
- (d) testing in search for, or evaluation of, product, service or process alternatives;
- (e) design, construction and testing of pre-production prototypes and models and development batches;
- (f) design of products, services, processes or systems involving new technology or substantially improving those already produced or installed;
- (g) construction and operation of pilot plants.

cf. Frascati:

- (a) creative work undertaken on a systematic basis in order to increase the stock of knowledge and the use of this stock of knowledge to devise new applications (para 43)...basic research is experimental or theoretical work undertaken to acquire new knowledge;
- (b) the use of this stock of knowledge to devise new applications (para 43);
- (c) if calculations, designs, workshop drawing and operating instructions are made for the setting-up and operation of pilot plants, they should be included in R&D (para 58);
- (d) feasibility studies ... on research projects are part of R&D (para 51);
- (e) the design, construction and testing of prototypes ... when any necessary modification to the prototype(s) have been made and testing has been satisfactorily completed, the boundary between R&D has been reached. The construction of several copies of a prototype to meet a temporary commercial, military or medical need after successful testing of the original, even if carried out by R&D staff, is not part of R&D (para 72);
- (f) experimental development is systematic work ... that is directed towards producing new materials, products or devices, to installing new processes, systems and services, or to improving substantially those already produced or installed;
- (g) the construction and operation of a pilot plant ... as long as the principal purposes are to obtain experience and to compile engineering and other data ...

Activities Normally Excluded From R&D

SSAP13:

Examples of activities that would normally be excluded from research and development include:

- (a) testing and analysis either of equipment or product for purposes of quality or quantity control;

- (b) periodic alterations to existing products, services or processes even though these may represent some improvement;
- (c) operational research not tied to a specific research and development activity;
- (d) cost of corrective action in connection with break-downs during commercial production;
- (e) legal and administrative work in connection with patent applications, records and litigation and the sale or licensing of patents;
- (f) activity, including design and construction engineering, relating to the construction, relocation, rearrangement or start-up of facilities or equipment other than facilities or equipment whose sole use is for a particular research and development project;
- (g) market research.

cf. Frascati:

- (a) tooling and engineering (one of 5 activities other than R&D which is involved in scientific and technological innovation) . . . covers all changes in production machinery or tools, in production and quality control procedures, methods and standards required to manufacture the new product or to use the new process (para 16). The routine testing and analysis of materials, components, products, processes . . . etc. (para 50);
- (b) final product design or engineering (one of 5 activities other than R&D which is involved in scientific and technological innovation) . . . is the further modification of a product or process after the R&D phase is completed in recognition of market or manufacturing requirements (para 51);
- (c) many social scientists perform work in which they bring established methodologies and facts of the social sciences to bear on a particular problem, but which cannot be classified as R&D. Examples of such work are . . . operational research as a contribution to decision making (para 58);
- (d) 'feed-back' R&D . . . after a new product or process has been turned over to production units, there will still be technical problems to be solved, some of which may demand further R&D . . . such feed-back R&D should be included (para 77);
- (e) all administrative and legal work connected with patents and licences (para 53);
- (f) if calculations, designs, workshop drawing and operating instructions . . . are carried out for the preparation, execution and maintenance of production standardisation . . . or to promote the sale of products . . . they should be excluded (para 58);
- (g) allied activities using the disciplines of the social sciences, such as market research (para 57). Market surveys are excluded (para 49).

MINUTES OF EVIDENCE

TAKEN BEFORE THE SELECT COMMITTEE ON SCIENCE AND TECHNOLOGY
(SUB-COMMITTEE II)

THURSDAY 2ND MARCH 1989

Present:

Carver, L. (Chairman)
Chorley, L.
Kearton, L.

Kirkwood, B.
Lockwood, B.
Nelson of Stafford, L.

Letter from the Science Policy Research Unit

I am replying to your letter dated 31st January to Professor Oldham.

1. *The Public Use of Science and Technology Indicators.*

I write this submission as a member of a University-based Research Unit on Science and Technology Policy. On the whole, we are users rather than producers of R&D statistics. However, we have also contributed to the development and use of a range of statistical indicators for scientific and technological activities; scientific papers, citations and judgments of scientific peers; expenditures on basic research; counts of significant innovations; US patenting by countries and by companies. The papers attached reflect the uses to which we put this data (not printed).^{*} The Research Councils have played a major role in supporting this kind of research.

Our general view on science and technology indicators is that:

- (a) There is no single, perfectly satisfactory measure of scientific and technological activities. For this reason, several measures need to be developed and compared, in order to identify both common patterns and inconsistencies;
- (b) More reliable and systematic data on scientific and technological activities contribute to improved analytical and theoretical understanding, to more realistic public perceptions and (hopefully) to better public and private decision-making;
- (c) R&D statistics—like many other statistics—have attributes of a ‘public good’; the benefits to society of their provision are likely to be greatest when they are made freely available to potential users. Governments are therefore justified, on grounds of economic efficiency, in subsidising the collection and publication of R&D statistics, and in supporting the mandatory disclosure of expenditures on R&D activities by publicly quoted companies;
- (d) Improved statistics on science and technology have already helped to provide convincing evidence of the importance of technological activities in explaining international differences in performance in economic growth and exports, and inter-company differences in stock markets evaluations.[†]

2. *The Advantages and Drawbacks of R&D Statistics*

- (a) R&D statistics have the very considerable advantages of having been developed over the last 30 years on the basis of definitions commonly agreed at the OECD, and of being accepted by politicians, journalists, administrators, firms and academics as the main measures of scientific and technological activities;
- (b) R&D activities have their particular difficulties in measurement: the cut-off between development and testing; the allocation of faculty time in higher education between research, teaching and other activities; international comparisons when input costs (mainly personnel) vary amongst countries. But there is no evidence that these difficulties are any greater than in other commonly used statistical measures, such as assets and profits;
- (c) Nor is there evidence that R&D statistics are collected in the UK in a manner different from other countries, or with greater or lesser rigour and honesty. What R&D statistics show for the UK is very similar to what other indicators of scientific and technological activities show, namely, decline

^{*}K Pavitt, ‘The Size and Structure of British Technology Activities: What we do and do not know’, *Scientometrics*, volume 14, No. 3-4, 1988.

K Pavitt & P Patel, ‘The Elements of British Technological Competitiveness’, *National Institute Economic Review*, November 1987.

K Pavitt & P Patel, ‘The International Distribution and Determinants of Technological Activities’, *Oxford Review of Economic Policy*, volume 4, No. 4, 1988.

J Irvine & B Martin, ‘Is Britain Spending Enough on Science?’, *Nature*, volume 323, 16 October 1986.

B Martin, J Irvine, F Narin & C Sterritt, ‘The Continuing Decline of British Science’, *Nature*, volume 330, 12 November 1987.

[†]J Fagerberg, ‘A Technological Gap Approach to Why Growth Rates Differ’, *Research Policy*, volume 16, 1987.

J Fagerberg, ‘International Competitiveness’, *Economic Journal*, volume 98, 1988.

A Pakes, ‘On Patents, R&D, and the Stock Market Rate of Return’, *Journal of Political Economy*, volume 93, 1985.

2 March 1989]

[Continued

relative to other OECD countries. At the same time, there may be particular British problems of measurement that deserve attention, in particular, definitions used (by industrial firms and by Government) for R&D in the aerospace industry, and the attribution of industrial R&D to different product groups.

- (d) R&D has a number of intrinsic shortcomings as a measure of technological activities: (i) it reflects very poorly the technological activities of firms with fewer than 1,000 employees, where small size often does not justify the establishment of a separate R&D department; (ii) it also does not reflect technological activities undertaken in the Production Engineering Departments of large firms; (iii) as a consequence, it under-estimates the total amount of technological activities undertaken in the development of capital goods (mechanical engineering, instrumentation, metal products, etc); (iv) it also reflects, only very imperfectly, the development of small software technology undertaken in Systems Departments of large firms, and in software houses; (v) it is an input, rather than an output, indicator;
- (e) None of these intrinsic shortcomings point to a redefinition of R&D activities. They simply reinforce the importance of experimenting with the development of other indicators of scientific and technological activities. In the UK, such experimentation has been strongly encouraged through the research programmes and projects supported by the ABRC and ESRC.

3. Possible Areas for Action

In the light of the above, we would draw the following subjects to the sub-committee's attention:

- (a) The adequacy and quality of published statistics on R&D activities in the UK (see 1c and 2c above);
- (b) Support for the development of supplementary indicators of scientific and technological activities (see 2d and 2e above).

I hope that the above is useful.

Professor K L R Pavitt,
Deputy Director

February 1989

Examination of Witnesses

PROFESSOR KEITH PAVITT, Deputy Director and Mr PARI PATEL, Professor Pavitt's collaborator, Science Policy Research Unit, called in and examined.

Chairman

1. Good afternoon. Thank you very much for coming here this afternoon and also for the papers that you sent us, including your reply to our letter. We all have name plates in front of us except Roger Williams, our specialist adviser and Dr Harrison, our specialist assistant, who may be known to you. You are obviously clear in your mind about what we are trying to do because you sent us such a very clear answer in your letter. I would remind you that at this stage we are just at the lift-off stage, at the end of which we will make up our minds whether to fire the rockets for a second stage and go into a further inquiry. What we are trying to do is make up our minds whether it is worth our while to go into a further inquiry in which we would send out questionnaires on the line of the letter of which we sent you a draft. As is clear to you, I am sure, the reason we are having this study is that we find a considerable degree of dissatisfaction both in our Committees and elsewhere with both statistics as at present available and also the use to which they were being put. You have done a great deal of very valuable research in this field. Would you like to expand on the papers you have sent us to start off with?

(Professor Pavitt) Thank you, my Lord. You sent a list of questions in relation to which I have consulted colleagues and do have answers. Probably you do not want to go through them one by one;

suffice to say simply by way of preliminaries that we welcome your interest in the subject, and think it is important. Anything we can do to help, we shall. I think there is room for dissatisfaction, and in fact one of the issues that I did want to bring up, which is not raised explicitly in your list, is the quality, accessibility and timeliness of British statistics compared with those in other countries, and perhaps that is something we can turn to at a time you think appropriate. That is all I want to say by way of introduction, I think it is probably better I answer your questions.

2. Perhaps you could start off by commenting on the annual review of Government research and development? Have you general comments about its value and the use to which it is put?

(Professor Pavitt) I do not think any one individual can have an authoritative opinion on the uses to which it is put. Statistics are by their very nature a public good. They are used by large numbers of people as one input to their perceptions and their decision-making. The effects are very dispersed and therefore it would be very anecdotal and misleading for me to say, "They are used this way". What I can say is the way we use them. My colleagues tell me they do use the annual review in relation to a number of research programmes—defence R&D, the evaluations of the ALVEY programme, our concern with European research and development programmes, the Government's biotechnology

2 March 1989]

PROFESSOR KEITH PAVITT AND MR PARI PATEL

[Continued]

[Chairman *contd.*]

programme—and we find in all these areas this document to be useful. It was a very important initiative taken by the Cabinet Office, not a functional department, some years ago. We think, however, there are a number of directions in which it could and should be improved. If you actually look at the most recent one for 1988, there are disquieting signs of things being left out which were in before. I think it would probably be more useful if I started by pointing out the gaps rather than what is good, with a view to thinking how it might be improved. The three or four areas where we think it could be improved are, first, in knowing where Government money goes to. There used to be a table in earlier years, which I cannot find in the latest review, which listed as columns all the Government departments as sources of funds, as was the different industries receiving the funds; and it was possible to see thereby how much money was going, for example, from MOD into the electronics industries, aerospace industries, and the like. That table is not available in the most recent Annual Review, and we think it is a very important table if we are to understand the impact of policy. Second, another table which is not here concerns the Research Councils, and specifically it would be good to know what percentage of Research Council money is spent in universities, Government laboratories and internationally. There are very important policy implications related to that distribution, and there is no table in the Review. Third, the data on industry is grossly inadequate, as is the gathering of data on business enterprise R&D, which reflects underlying inadequacies in what is going on in the Department of Industry. I am not casting doubt on the commitment or competence of the official involved, but it seems to me they have too few resources to do a decent job compared to other countries. Finally, I think much more use could be made, as in other countries—and I have brought some documents from Australia, the USA and Canada—of other indicators (bibliometric indicators of papers, patents, citations and so on) especially for the purposes of international comparison, because it is extremely important to understand how well or badly Britain is doing compared to the rest of the world. I have been rather blunt about what I think the limitations are, and there are other examples I can give; there is a need for greater specificity, for example, on the defence question.

3. That information is not obtainable, for instance, from the Research Councils by looking at their annual reports?

(*Professor Pavitt*) Yes, it could be, but I think that for tired academics or tired policy-makers, it would be useful to have these data together in a reasonably accessible, open fashion. However, there are data on industrial R&D which are not as good as we think they should be, and I have a letter from a colleague, David Sawers, a very distinguished economist in this area, who said I could pass it on to you, pointing out the inadequacies of British industrial R&D statistics compared to those in other countries, and the difficulties he has found in getting hold of them.

Lord Chorley

4. Which other countries are good in this respect? (*Professor Pavitt*) United States, Canada, increasingly Australia, Japan. On Government, Germany; the German Government puts in a report every two years to Parliament on Government R&D expenditures in great detail. Some of these statistics we have here.

Lord Kirkwood

5. Is it a mandatory requirement that research and development spending by companies should be revealed in their annual reports? Is that the source of information?

(*Professor Pavitt*) No, my Lord. As far as I know, in no European country is such mandatory disclosure required, but for reasons which I cannot explain, but can only observe the consequences of, more resources and concern is spent on collecting statistics and presenting them either on what Government does or what industry does. The industry data are not on a firm by firm basis, but on a sector by sector basis.

Lord Nelson of Stafford

6. Is that inadequacy due to lack of definition as to what is research and what is development, or is it lack of willingness on the part of a firm to disclose it, or lack of actual knowledge within the firms?

(*Professor Pavitt*) I cannot answer the last question. I would guess that would be variable, but the real problem seems to be that, compared with what happens in the other countries I have mentioned, British statistics on business enterprise R&D come out later and in far less detail. We have anecdotal evidence to suggest that increasingly these data are being almost “privatised”, one has to pay for what was previously freely available. I think this reflects to some extent the inadequate level of resources given to survey activities in the Department.

7. Have you, or anybody, talked to industry through the trade associations on that issue at all?

(*Professor Pavitt*) No. We have talked directly to the Department itself and we have made comparisons with other countries through our links with OECD. We have also spoken with analysts in various firms, and we do note in this country considerable variability in the seriousness and adequacy of the R&D data collection. But I think the reason why the British industrial statistics on R&D are weak is the lack of resources in Government devoted to their collection.

Baroness Lockwood

8. When you say that information which was previously freely available is now only privately available, that would seem to suggest that the information has in the past been collected but it is not now being published?

(*Professor Pavitt*) That is right.

9. What kind of information are you talking about?

(*Professor Pavitt*) If you look at the latest Business Monitors on industrial R&D, there are

2 March 1989]

PROFESSOR KEITH PAVITT AND MR PARI PATEL

[Continued]

[Baroness Lockwood *contd.*]

fewer tables than there were in the earlier Business Monitors on industrial R&D. The data are coming out rather late compared to other countries. I have data here which came out mid-summer last year in Canada going up to mid-1987, whereas the equivalent British data are only published up to 1985.

Lord Nelson of Stafford

10. Is there any agreement about what are the definitions which lie behind that data? You raised yourself in your own paper production development—is that D or is it not? The development of new processes—is that D or is it not?

(*Professor Pavitt*) Well, my Lord, any statistics measuring profits, sales, assets or anything else are imperfect, and I would not say R&D statistics are any more perfect.

11. Those countries you mentioned which do it quite well, do they define what they mean?

(*Professor Pavitt*) Yes, they all adopt OECD definitions.

12. But the OECD does not define that.

(*Professor Pavitt*) It does define the difference between development and production, but as you well know there are problems of interpretation in the British defence industry.

Lord Kearton

13. You have said that information on industrial R&D is late, weak, and at the beginning you said it was grossly inadequate. "Grossly inadequate" is a strong phrase, would you like to quantify it?

(*Professor Pavitt*) In the terms I have just described: it comes out late compared to other countries, it is not broken down in great detail. There are also anomalies which need to be explained. I have here some data on the 1985 survey, the first preliminary results published in February, 1987, and subsequent results in July, 1987, during which time there were the normal corrections you would expect, but also some enormous shifts between areas like instruments, machinery and automobiles, and within electronics between components, instruments again, and electronic capital goods. The reason is that very often R&D in several sectors is performed within the same companies. We are not clear whether allocations to sectors are being made according to the principal activity of the firm, or the particular product line, and it is impossible to find out.

14. Can you give an example of "an enormous shift"?

(*Professor Pavitt*) Mechanical engineering between the February 1987 report and the July 1987 report went down from £393 million to £262 million, which I would interpret as an enormous shift. Motor vehicles went up from £270 million to £370 million, which makes the British automobile industry look good. Some of my colleagues who are working on the British automobile industry are very sceptical about that shift, I think the explanation is that there has been a shifting of the pawns around the board.

Lord Nelson of Stafford

15. Which would the automobile components be in? Mechanical engineering?

(*Professor Pavitt*) Exactly the point, my Lord. Where you put Lucas becomes extremely important. These are difficult problems. There is no transparency at the moment in how this is done, and these enormous shifts suggest there is no consistency in the manner in which they are done. What you want is consistency. You can see here the British automobile industry looking very good and British mechanical engineering looking very bad. What it might mean is, rather like shifting bits of the Austro-Hungarian Empire, you pick out Lucas and put it here rather than there.

Lord Kearton

16. You think industrial R&D is under-stated because you are not taking into account the work carried out in smaller firms, do you have any personal opinion how much these would increase the figure for industrial R&D?

(*Professor Pavitt*) May I say, in taking up that issue, we are shifting out of the particular problem of British statistics to the problem of R&D statistics in any country. Yes, there is evidence to suggest that R&D statistics considerably under-estimate technology or innovative activity in firms with fewer than 1,000 employees. The reason for this is that small firms do technological things but they do not have R&D departments because they are small; the degree to which firms have R&D departments for their technology depends to some extent how big they are. There have been a number of studies of innovative activities in smaller firms—we have done some and there have been others in the United States—which suggest that in firms with fewer than 1,000 employees, where the R&D expenditure is 2 or 3 per cent. of the total, the percentage of innovations can be between 25 and 40 per cent., which is an enormous order of magnitude difference. In addition, I picked up last week a report from the Policy Studies Institute which is called "Small Firms' Innovation", and about regional differences in small firms' innovation. They studied a number of engineering firms in the Midlands and the North East and only 10 per cent. of these, mainly machinery businesses, had R&D departments. Another 30–40 per cent. said they performed R&D activities, but they did not have departments. So I think R&D statistics are very bad indicators of technological activity in small firms.

Chairman

17. If you measure these inputs either by finance or by personnel employed, how are you going to represent more accurately the innovative work being done in those small firms which do not employ a large number of people and do not use a lot of money?

(*Professor Pavitt*) That is a very good question. I do not think there is any perfect way of doing it. One must accept R&D, conventionally defined as a separately accountable physical entity in and around a laboratory, is not going to capture what happens in small firms. One therefore has to look for other

2 March 1989]

PROFESSOR KEITH PAVITT AND MR PARI PATEL

[Continued]

[Chairman *contd.*]

measures. There are small firms which have technological activities which are called design and not R&D. So I think one is forced to explore other measures. One measure that we have used at SPRU is the counting of innovations, but it is very time-consuming and you cannot do it on a regular basis in Government. Another possibility would be to use patent statistics, but there the problem is identifying firms below 1,000 employees. We hope we will be able to do that in our research programme in the next five years. In the meantime, nobody has developed a regular review in any country which will reproduce retrospectively and reasonably economically the technological activities in small firms.

Lord Nelson of Stafford

18. How do the Germans do it if they produce such good figures?

(*Professor Pavitt*) Basically they do not do much better than we do. This is not a particularly British problem; it is a generic problem with R&D statistics.

19. So for comparison purposes it is probably not all that important, because they all have the same problem?

(*Professor Pavitt*) Exactly, that is right. Where you might have a problem is in a country like Italy, which compares unfavourably with R&D statistics. We have a post-graduate student who looked at patenting statistics in Italy, and found that a lot is happening in small firms in and around textiles, leather and machinery—very Italian things like Benetton—that are very important in Italy with regard to technical change.

Chairman

20. Are there any other ways, other than by looking at patents, in which you could try to assess innovation? Output rather than input?

(*Professor Pavitt*) I did not say I used patents as an output measure; I use them as a proxy measure of technological activity. There are reasons why it is dangerous to think patents as output, simply because patenting is used differently across industries. I do not know whether there are other methods.

Lord Chorley

21. Are you talking about inputs or outputs?

(*Professor Pavitt*) Activity.

Lord Chorley: That is input, I think.

Baroness Lockwood

22. What is the difference?

(*Professor Pavitt*) If I take, for example, the counting innovations as an output measure, you will find there is a great deal of incremental improvement which you do not capture by measuring outputs of specific innovations. What I mean is that one is measuring the complex phenomenon of technical change, and it is like putting instruments into a complex process. You can measure and monitor bits and pieces of it through R&D, patenting, through counting discreet measured innovations, through asking experts in other countries how good is this company or country, and getting judgments of peers,

if you like. All these measurements are imperfect. What one is doing is putting them together to see if they tell a consistent story. Eventually one hopes to get productivity measures of all the technology inputs compared to all the technology outputs, but I do not think one is in that position yet. One is in a position of measuring imperfectly various parts of a complicated process.

Chairman

23. But to go back to your comments on the inadequacy of industrial statistics, is that because the Department of Trade & Industry is not asking enough of the right questions, or questions in sufficient detail, or is it because of reluctance by industry to produce the information?

(*Professor Pavitt*) I cannot answer that question. All I would say is, back to the late 1960s, much more detail and regular statistics were collected in what was then the Ministry of Technology. I am not making a party political point, but at that time more resources were being given to this particular activity, and there did not seem to be any reluctance at that time by industry to supply quite detailed statistics.

Lord Nelson of Stafford

24. It has been suggested that industry should be obliged to publish its figures on R&D, but it does not sound as though they are going to be of very much value, even if they are published, judging by the inadequacy of them?

(*Professor Pavitt*) I think, for large firms quoted on the Stock Exchange, such data would be extremely valuable. In fact, there have been studies done in the United States, where R&D expenditures are subject to mandatory disclosure for quoted firms, which show that these data are taken into account by stock market analysts in establishing stock prices.

25. If the statistics are not worth anything, it could be very dangerous, could it not?

(*Professor Pavitt*) I am one of those people who believe that one makes progress by developing statistics and improving them. If one believes in markets in the allocation of resources to technology, their efficient functioning depends on the availability of good information. We cannot expect markets to allocate resources efficiently if there is inadequate information on what is a central feature and central resource with regard to modern companies, which is their technology and R&D resources. It seems to me there is a very strong case, especially in a decentralised market system, for getting even better information available to a wide number of people, in order for it to work effectively.

26. In other words, you are saying this would be a move in our getting better statistics?

(*Professor Pavitt*) I am saying if you want markets to work in a decentralised and efficient way, one of the pre-conditions is having good information for decision-makers about the system.

2 March 1989]

PROFESSOR KEITH PAVITT AND MR PARI PATEL

[Continued

Baroness Lockwood

27. But would the information that they require to be published be given on the same criteria as the DTI now ask for it from industry? Would you suggest some different kind of criteria if it is going to produce better statistics?

(*Professor Pavitt*) I would suggest the same criteria as the DTI. The inadequacies of the published statistics in the UK do not relate, as far as we can judge, to inadequacies in definition but inadequacies in resources for their collection.

28. But how do you get this difference, which you refer to, between the shift in mechanical engineering and the shift in other industries? Is that because the criteria is not adequate or is that because it is capable of being interpreted in different ways?

(*Professor Pavitt*) It is because the data coming from companies on R&D expenditure can be allocated to different industrial categories, and we do not know at present how that is done. In fact, if one day there is mandatory disclosure of R&D statistics on a company by company basis, in the way Lord Nelson suggested, it would then be possible precisely to clear up this puzzle.

Lord Chorley

29. But would it be? For example, just thinking aloud, if you take a large group—it might be Lord Nelson's group but let us say ICI—they would give you basic research and applied and developmental work, whatever it is called, but they will not give it as between petro-chemicals and pharmaceuticals.

(*Professor Pavitt*) Some might.

Lord Kirkwood

30. Who is putting these things into different industrial categories and making different assumptions of the definitions of the categories themselves?

(*Professor Pavitt*) Somebody in the Department of Industry.

31. And a variety of statisticians will provide different categories?

(*Professor Pavitt*) It is very difficult to find out. Not only is one trying to deal with the Civil Service from the outside, but one is dealing with the way in which statistics on companies are put together and even within the Civil Service, statisticians have a mandatory obligation not to disclose precisely how they do that, so it is a Kafkaesque situation. There is no transparency, and it is not clear how these numbers have been shifted about over time.

32. The statisticians themselves do not comment on them?

(*Professor Pavitt*) They are not allowed to.

Lord Kirkwood] They do not recognise there are certain changes taking place?

Chairman

33. But are there not bodies other than the DTI which collect statistics—for example, industry associations—or do they rely entirely on what is collected by the DTI?

(*Professor Pavitt*) There are sometimes partial statistics and surveys put out by other bodies. For

example, the magazine *The Engineer* sometimes does its own small-scale surveys. The Electronic Industries Association and one or two others sometimes put out data on R&D in the industry on a "bitty" basis. The only comprehensive surveys are those done by governments. The only other non-government surveys were those funded in the nineteen-thirties and fifties by what was then the Federation of British Industry (FBI). In the United States there are private organisations doing surveys, like McGraw-Hill.

Lord Nelson of Stafford

34. The aerospace industries put out a paper saying that the statistics relating to the industry were not a true reflection of the industry. You probably saw it?

(*Professor Pavitt*) Yes. That was something else that was in your list of questions. One of my colleagues, William Walker, has asked me to bring to you a little document called "UK Defence Electronics—a Review of Government Statistics". He brings up the question of the inconsistency between what government and industry say regarding R&D in aerospace and the like. This problem goes back a very long way. The FBI survey done in the fifties ran into the same problem. Pre-production costs in aerospace are part of R&D as far as the Government is concerned. As to civil launching aid, the DTI has a similar broad view as to what R&D might include. What I would argue is that it would be wrong to neglect these pre-production activities. Even if they are not strictly speaking R&D it is important to have data on them, because their opportunity cost or spin-off effects are likely to be considerable; they make intense use of skilled personnel.

Chairman

35. Do you suggest that Frascati adds on to experimental development engineering development as something further within development or not within development at all?

(*Professor Pavitt*) I think one should not tamper too much with the basic Frascati concepts, since they have been tried and accepted in a number of countries. I think there are areas where one might want to try to collect data on additional scientific and technological activity, and one area might be precisely production engineering and pre-tooling; another might be small firm technical activity of the sort we talked about earlier. There is another one which did not get sufficient attention in the note I sent to you: software. This is not a British problem but an OECD-wide problem, in that software is a new form of technological change. Sometimes it is produced in what we call R&D departments, especially in firms like ICL or IBM, the suppliers of both hardware and software. But it is being produced increasingly in software houses, and also systems departments within service firms such as banks, insurance companies, and the like. It is not called "R&D", but there is a lot of new technology being developed, not for processing materials but for processing information. That is going to become increasingly important in future. I think this presents a challenge in two senses. First, how does one deal with software in relation to the Frascati Manual? That is one area where I think there might be a case for adapting the

2 March 1989]

PROFESSOR KEITH PAVITT AND MR PARI PATEL

[Continued]

[Chairman *contd.*]

Frascati Manual to include the new technology-generating activities being carried on in large companies, not in R&D labs but in systems departments. There may be a case for adapting the manual in that respect. Secondly, there is an even stronger case for improving coverage of technological activities—call it R&D or whatever—not only in manufacturing but in service sectors, because the interesting point about software technology is that it is increasingly being developed in locations not previously associated with the generation of technology—banks, grocers, Marks & Spencer and so on.

Lord Nelson of Stafford

36. You seem to be distinguishing between what is not innovative software?

(*Professor Pavitt*) That is quite right. That is an extremely difficult problem. What is just programming and what is a real development of software technology? All I am saying is that there is a very important challenge, which no country has taken up, and which would require more resources if it was to be tackled properly. This is a point which the OECD may have taken on board already. It will require changes in habits, because it means looking for technology in places one has not looked at before.

37. Reverting to the controversial area of aerospace, like flight-testing, engine-testing, and so on, these activities require big sums which can have a dramatic impact on costs. Do you find that other countries involved in these activities, like France, Germany and the United States, interpret the term R&D in the same way as the Ministry of Defence?

(*Professor Pavitt*) I cannot answer that question with regard to the statistics; I cannot say what inconsistencies there might be between government and industry in these different countries.

38. But it is important?

(*Professor Pavitt*) Yes. I do know that, in terms of concepts, the United States Defense Department and other departments distinguish between research, development and testing; they admit to distinctions between those activities. What the different habits and inconsistencies are I cannot say.

Chairman

39. But Frascati say, for example, that the first prototype should be regarded as development and the second and third should not?

(*Professor Pavitt*) Yes.

40. So that if you follow Frascati you should be fairly all right on this, should you not?

(*Professor Pavitt*) You should. I become rather pessimistic about one's ability to change it, at least in this country, because for nearly 30 years there has been this problem of inconsistency between what Government and industry say in aerospace.

41. And the figures are so large they distort the whole picture?

(*Professor Pavitt*) Again this is where you have to be rather careful because although by Frascati definitions you are quite right that activity beyond the first prototype is not development, from a policy

point of view lots of technical and financial resources and people are tied up in the subsequent stage, and it would be wrong to sweep that under the carpet one way or another.

Lord Kearton

42. Let me take two examples—the modernisation of Polaris and the Chevaline programme—which were originally estimated at about £100 million and the final cost was over £1 billion. Was that R&D or was it classified and returned as R&D?

(*Professor Pavitt*) I cannot answer that question. You can probably answer that question much better than I can.

43. If you take the Nimrod programme, is that R&D or product engineering, would you think?

(*Professor Pavitt*) Again there are other people round this table who can answer that question better than I.

Chairman: I would guess that actually the Nimrod programme was all within R&D; it did not reach production or order stage.

Lord Chorley: This does bring one back to the question of useful output. You said you did not regard output as being a measure of activity, which I interpret as being a measure of expenditure. Are there any useful measures of output, in your view?

Lord Kearton

44. Balance of trade in technical products?

(*Professor Pavitt*) You get into problems there of how you define high technology. If you take certain definitions, Britain and the United States look better than Germany and Japan simply because you include aerospace and exclude mechanical engineering and automobiles. You can therefore get into all sorts of difficulties with how you define high technology industries. Let me be clear. What I have said about output is very much my own view. Some of my colleagues would say that, if you are careful, you can use patenting or counting discrete innovations as an output measure, provided you do it over a relatively short period, and for firms in the same industry. But you have to be careful. You cannot compare the ratio of patenting to R&D in fabricated metal products and in aerospace and conclude that the former is 100 times more productive than the latter. No, I do not see any easy, quick mechanical method of comparing inputs and outputs. The data always require interpretation, even on the input side. If you take small firms, you will find the numbers of innovations per unit R&D is extremely high. Does that mean small firms are more efficient than big firms? Answer, no. It is simply that R&D activity is only a small part of what is happening with small firms in terms of technology input. A very careful interpretation is necessary, and a mechanical system would be extremely dangerous.

Chairman

45. But to get to the basics, if there are all these difficulties in the adequacy of the statistics and the interpretation and everything else, what do we want the statistics for?

2 March 1989]

PROFESSOR KEITH PAVITT AND MR PARI PATEL

[Continued]

[Chairman *contd.*]

(*Professor Pavitt*) I thought you might ask me that!

46. Are you saying that either with present statistics or better statistics, if you were somebody with money in the market you could forecast that that is a good firm to put your money into now and that is not? Looked at from the Government's point of view, is that something which the Government should support or not on the basis of the statistics that are made available?

(*Professor Pavitt*) I think no statistics make decision-taking easy. There are no statistics on R&D or anything else that will tell you which horse to back, or which football team or which firm to put your money on. That is why people are paid sometimes quite high salaries to read the statistics and then to use their judgement to make decisions. I am often asked, "Why do you not tell policy-makers what they should do?" and my answer is, "They are paid quite high salaries to decide what they should do. It is not for me to tell them." What I think the data are there for — and this is something you would understand — is intelligence. Intelligence is always imperfect; you get it from various sources and you have to cross-check. You want to know what your partners and enemies or potential enemies are doing, and you want all the systematic information available. You know it is imperfect, and it cannot predict the future, but you hope that by having it you will take better decisions than when not having the data. It does not take away the difficulties of interpretation by the policy-makers, but hopefully it makes them better informed. I am impressed — and I do have to be careful what I say — that the Japanese collect a lot of data and interpret a lot of data on R&D and other things.

47. The Japanese government?

(*Professor Pavitt*) The Japanese government and Japanese firms. They publish quite a lot of data.

Lord Chorley

48. So you would add one more point, that we ought to spend much more doing it? To be sufficiently useful it would be worth spending a lot more?

(*Professor Pavitt*) I have an interest to declare in this, being an academic research institute in this area. It helps to make our job easier and more interesting to have good data. I would only point out that these data on R&D, like data on training, help concentrate minds on what makes advanced countries, high-wage countries and firms, competitive. If you compare the quality of the data we have on R&D and training with financial data it is grossly inadequate. I am also struck by the growth of specialised service firms like Derwent Patents, and big firms are increasingly interested in obtaining the data on what competitors and partners are doing in technology. There are entrepreneurs collecting not general public purpose statistics, but private statistics and making money out of it, which suggests that there is a demand.

49. I seem to recall about two years ago the DTI launched something called the The Tradeable Information Initiative. I have not heard since whether that launch was successful, that is to say, whether anything happened or not, but I think the idea was that if there was value in this data people

would buy it and the Government would be repaid for the effort.

(*Professor Pavitt*) I was very careful to say where you have a clearly defined and specialised requirement for it. The point about R&D statistics is that interest in them is dispersed amongst a great many users. They are one input amongst others that will go into decision-making. They have the characteristics of a classic public good. They are of use to many but the incentive for any user to develop them is insufficient. Even Milton Friedman would say in such circumstances there is a strong economic case for public subsidy, and that is why governments subsidise the collection of statistics which have this general purpose function. In that sense, coming back to the point I made earlier in relation to Lord Nelson's questions, for the efficient working of markets one needs better and more rigorous published information in this area.

Chairman

50. In general you would be in favour of sticking as closely as we can to Frascati and not introducing new terms like "strategic" or "near market" or anything else?

(*Professor Pavitt*) That is right, yes.

51. You would not want to put in "strategic" as a subdivision of applied research?

(*Professor Pavitt*) No. I think there are advantages to simplicity and continuity. The only area that I think does require a somewhat radical re-think is the software question which I raised.

Lord Nelson of Stafford

52. In your paper you raise something not taken care of here. You say that statistics do not reflect technological activities undertaken in production engineering departments of large firms. That is quite big money?

(*Professor Pavitt*) Yes.

53. How do you think it should be done?

(*Professor Pavitt*) That is precisely the issue we talked about earlier in relation to aerospace: What comes after the R&D? I think you need special surveys.

54. Frascati does not deal with it very well?

(*Professor Pavitt*) That is where patenting statistics are useful. You have a much better feel for the production technology from patenting than from the R&D statistics. That is another way of getting at the problem. There is a case for special surveys for post-R&D activities in certain industries. It is not important in pharmaceuticals; it would be a waste of time, but it would be useful in the automobile and aerospace industries. I know special surveys have been undertaken in Canada, the United States and Israel by academics, so you have data on post-R&D activities which turn out to be of the same order of magnitude as R&D itself.

55. If we look at Japanese statistics, their very successful activities over the last 20 years have been due to their devotion to production development?

(*Professor Pavitt*) Yes.

2 March 1989]

PROFESSOR KEITH PAVITT AND MR PARI PATEL

[Continued]

Lord Kirkwood

56. Do they also produce statistics in this area; do they keep them separate?

(*Professor Pavitt*) Not in English, not in the OECD reports. There are all sorts of surveys going on in Japan which generally do not get here.

57. Do you mean regular surveys or one-off surveys?

(*Professor Pavitt*) In addition to regular R&D surveys in Japan the Science and Technology Agency, or MITI, undertake special surveys into subjects like how their technology compares with the rest of the world, and to what extent are companies' activities based on foreign technology. They have done this since the nineteen fifties. Some of these surveys are translated into English, but generally they are not translated. They may also do surveys on production engineering.

58. Of course, doing regular surveys means you are collecting information over a long period, not just for one year?

(*Professor Pavitt*) Yes. They have done regular surveys on R&D and on how industrialists rate their position in the world league table in technology.

Chairman

59. Do you think the Economic and Social Research Council could do more in this field than they are doing already?

(*Professor Pavitt*) Again, it would be a matter of special pleading on my part; we at SPRU receive funding from the ESRC. I think there is a problem in the long-term relating to the establishment of competence. There is quite strong competence in the United Kingdom in academic bodies at present. I do not say that to sound immodest, and it is not just at SPRU; there is also Manchester and the Royal Society and other places. We are in a strong position, but it strikes me that the competence is in academia, and it has been nurtured largely by the ESRC and the ABRC. What worries me is that that competence is not embedded deeply in the government service. Most of the novel statistics coming out of the Cabinet Office, like the annual review of R&D, are done on a shoestring by people who rotate and who are not permanently in the Civil Service. There is no accumulation of competence, or mandate in the UK document service to improve the statistics on R&D and other measures of scientific and technological activities.

60. Should this be in the Central Statistical Office?

(*Professor Pavitt*) I do not know. I think one would be putting it in a place which has been rather undynamic in this area in the last 10-15 years. Compared to other OECD countries, the UK has relatively few officials working in this area. I think there is an interesting question about how one embeds this expertise in the long-term in the Civil Service and elsewhere.

61. Do we need something like an institute of industrial statistics?

(*Professor Pavitt*) I am in favour of pluralism; I think we need competence in all sorts of places, so that people can argue and take different perspectives.

Lord Kearton

62. The dilemma is that, even if we decided to do all these things, there is a question whether the statistics would be of any greater use than they are now. We start from the premise that statistics on R&D are not as good as they might be. We understand that at the moment the statistics are poor and you have ideas on how they might be improved, but from what you have said it seems that it comes down to personal interpretation in the end?

(*Professor Pavitt*) Inevitably, when you have figures which are imperfect there is a need for interpretation and debate about them, just as there is room for interpretation and debate about how one measures M3.

63. Would it not be more fruitful to look more and more at output rather than input? I agree that patents as a measure of output are extremely unreliable; patents are there to enshrine and protect important commercial advantages. Some of the most commercially advantageous things are obscured by patents so they cannot be copied. There must be a means of measuring output which is a better guide on how money is being spent—whether it is too much or too little?

(*Professor Pavitt*) I think it can be done at a laboratory level. In the same way that academic peers do it: a mixture of numbers from various sources, however imperfect, and professional judgment. I am very reluctant to find easy ways of relating R&D to output. What we can say is that countries with low levels of R&D have relatively poor economic performance compared with those who do more. You cannot say that their R&D is more or less efficient.

Chairman

64. What about Taiwan and South Korea?

(*Professor Pavitt*) I am sorry; I should qualify what I have said by saying "countries in and around the world's technological frontier, not the catching-up countries". Interestingly enough, the most successful of the catching-up countries that are starting to get near the frontier do a lot of R&D. Japan did not only production engineering but an enormous amount of R&D activity, and now Korea will soon be spending as much as the UK in the proportion of industrial output on R&D—catching up type of R&D. When countries start moving towards the world's frontiers they start putting resources increasingly into R&D.

65. This is genuine research and development and not just buying in other people's research?

(*Professor Pavitt*) A lot of it is reverse engineering. But R&D is needed if you want to reverse engineer properly.

66. Time is passing. You have given us a lot of food for thought. You had a copy of our draft letter to witnesses. Is there any other comment you would like to make on the questions which we posed, or do you feel we should have asked some other questions?

(*Professor Pavitt*) No; I think it is a very adequate document. There is nothing I particularly want to add. I think you are in a better position to answer some of these questions.

2 March 1989]

PROFESSOR KEITH PAVITT AND MR PARI PATEL

[Continued]

[Chairman *contd.*]

67. Thank you very much indeed. We are most grateful to you.

(*Professor Pavitt*) Thank you for taking the time to listen.

Letter from Sir Colin Fielding

In response to your letter of 31 January, I am enclosing one copy of a note under the same heading.

On thinking about how best to answer your questions, I decided to preface my answers with a short explanatory piece—I trust that your Sub-Committee will find it helpful to their deliberations.

I hope that the Sub-Committee will be able to find a way of amplifying the current Frascati definitions to reflect the needs of countries to look much more broadly at the contribution of *innovation* to national wealth creation.

Colin C. Fielding

February 1989

DEFINITIONS OF R&D SPENDING

In spite of Frascati, the term R&D is too frequently used to cover widely different quasi-innovative activities, particularly in technology and engineering which generates considerable confusion in interpretation by those who are not directly concerned with the particular industries or programmes.

As might be inferred from that statement, there is very little difficulty with academia because the Frascati definitions are generally well matched to the kind of R&D going on in those quarters.

But the vast majority of R&D is being carried out in Research & Technology Organisations (RTO's), the manufacturing industries including aerospace, pharmaceuticals, chemical and power generation companies, systems and software companies and government research establishments. In these areas the term R&D is still used to describe innovative processes but it can often have quite a different meaning to that in academia.

This ambiguity has led to considerable misinterpretation in the assembly of statistics across different spheres of activities in the UK. One unfortunate result has been that those trying to divine national policies for, and performance in R&D have been misled. Worse, there is more confusion still in the statistics across national boundaries. For example, if R&D is carried out in a technical institute, it is often classified as such within one of the Frascati definitions, but if similar work is carried out in private industry, it may only be partly referred to as R&D, within Frascati definitions.

To clarify why such confusion should exist, it is worth looking at the whole process of evolution of (say) technology, for I appreciate R&D can encompass a broader spectrum than that, but it is in that area where there is the maximum scope for misinterpretation.

Let us take the gas turbine engine as an example:

Basic research—

thermodynamics, properties of petroleum-based fuels, properties of metals.

Applied research—

optimisation of thermodynamic cycles, extension of turbine technology, metallurgical properties of required metals.

Experimental development—

design of laboratory gas turbines, design of performance measurement rigs, etc.

Engineering development—

general definition of a product, design of that product, manufacture of prototypes, development of an engine test facility, creation of drawings for manufacture, creation of technical specifications etc.

The ambiguities stem from the last two headings. Applied research, in industrial terms is frequently, but not always, nearer to Frascati "experimental development". Engineering development has no parallel in Frascati, but it does have a very finite innovative content, which could be 50% in some cases; *but* the whole

2 March 1989]

PROFESSOR KEITH PAVITT AND MR PARI PATEL

[Continued

process is often referred to as R&D (as distinct from manufacture) by many statisticians. The implication is that the step which precedes manufacture is necessarily development.

The ambiguity is not therefore in the "R", for there is a generally accepted convention about what research means, it stems from the "D", for this has a much wider meaning and significance in the industrial field.

Questions and answers

I. I use the term "engineering development" to describe the process of specific product development, and I use the Frascati term "experimental development" to cover what many scientists and engineers in industry might loosely classify as "applied research".

"Engineering development" can be a high cost process, for instance the cost of development of an aircraft, and statisticians will often attribute the whole of that, quite wrongly, to R&D. Nevertheless, in overall statistical terms, the proportion of cost attributable to the innovative element is by no means trivial and methodologies need to be developed to break out this element in a meaningful way which can be universally understood across the necessary boundaries.

II. (a) no.

(b) not in an adequate way.

These answers apply to (i) (ii) (iii) and (iv).

I would not usually use Frascati definitions in compiling company accounts.

III. I have tried to set out the answer in my preamble.

Examination of Witness

SIR COLIN FIELDING, Consultant in Defence Systems, Electronics and Information Technology, called in and examined.

Chairman

68. Sir Colin, thank you very much for coming along this afternoon and for your letter, which was a great help to us. I think you are fairly clear what we are trying to do and why we are trying to do it?

(Sir Colin Fielding) Yes, I think I am.

69. The Committee found itself dissatisfied with both definitions being used and what they were used for. Just to remind you, we are in a sort of lift-off stage of our inquiry at the moment and, unlike what usually happens, we may decide not to fire the second rocket, and we very much depend on your advice. It would seem to me from your written answers to our questions that in general you think some things are included at the moment in R&D which should not be and others which should be and are not included. The problem as we see it is that this is just because the existing definitions, which we assume must be based on Frascati, are not being used properly, that stuff is being put in there in a way that is not in accordance with the Manual or that the Manual itself is in some way deficient and we ought to suggest ways in which it could be changed. If you would perhaps like to enlarge on what you yourself have written we would be very grateful to hear it.

A. Thank you very much indeed. I think that it is perhaps worth starting off by saying that within the definitions of Frascati and the general background writing on Frascati there is no doubt about that and my personal concern would be that you can build a very large spectrum of activities that may be construed to be R&D but where the interpretation of what those numbers mean at the end of the day is subject to different interpretation depending upon what point you are sitting in the particular chain. I am talking in a by and large sense naturally, but if you take the areas of basic research and applied research, which are the first two categories of

Frascati, I think in the areas of research institutions, both in universities and Government research areas and so on, there is no doubt that there is a reasonably common understanding of what those mean and probably very little room for ambiguity there. As I was saying in my note, where I see the greatest problem is when you are moving beyond the applied research area into what Frascati calls exploratory development and where exploratory development can be construed to cover a very wide spectrum of activities, particularly as you move out of the more research-orientated environment into a more industrial and applications environment, where you are ultimately talking about developing a product and selling it in the marketplace and so on. Often I think the ambiguities arise there because there is this great gap between, at the right-hand end of the scale, the manufacturing process where at the end of the day you are going to produce the product you have designed and one might call that the end of the R&D phase of any kind of activity, and the left-hand end of the scale, the end of the applied research phase and the slightly ambiguous area of exploratory development, which does leave one with a host of activities going on which are very much open, I think, to misinterpretation. That is not to say that the people who are generating the data are doing it in any way wrongly. In some ways if I was to make one general point it would be that in my mind in relation to what I have just said there is perhaps a need to build on Frascati, not throw it to one side but to build on it, particularly in the third category of exploratory development, and to try and ensure that the exploratory development phase is better defined to spell out the kinds of processes that do actually occur in real life between the end of the applied research and the manufacture of a product in an industrial base. That to my mind is the key factor that probably would merit some attention in the sense of definition

2 March 1989]

SIR COLIN FIELDING

[Continued]

[Chairman *contd.*]

to try to see what are those steps and try to make the meaning of those steps understood generally, so that when companies, government organisations and so on are generating statistics or deriving statistics, that information effectively will be against some common base of understanding. I think that is the problem.

70. The Frascati Manual does give some examples in this field, does it not?

A. It does. I think all I am saying is in a way that the current usage (if I can put it that way) is quite clear about basic research and applied research. The danger is that you sweep into exploratory development a very large spectrum of activities and I think that if you are in the business, for example, of using statistics to measure wealth-creation or investment in R&D or something of that kind, it is quite important to have a better understanding about what the ingredients are of those exploratory development statistics than perhaps is obvious from most interpretations that are generated. That is all. In other words, it is saying it is all there but one cannot read into that what one needs to read into it.

Lord Nelson of Stafford

71. As a lot of the statistics are used for comparative purposes — one firm against another or one country against another — it is really rather more important, is it not, to have a common interpretation, in fact you might say an absolute interpretation?

A. Yes indeed.

72. If you take the defence field, which we touched on earlier, would you know whether the United States and Germany and France interpret their R&D in the defence field in the same way as we do, particularly in relation to these big figures on flight testing, aero engine design and so forth?

A. I think the answer is that there are minor differences of definition. I think in Germany they follow by and large the interpretation which we might have in the UK of effectively blocking into exploratory development virtually everything that occurs after applied research until you actually generate a set of drawings to produce a product. In the United States, although I do not pretend for one moment there is a readymade answer there, they do in their statistics generate a definition called research and development and trials and evaluation (RDTE) and, as I recall, the definitions break down into research. They do not try to say what is basic and what is applied, although in most instances in the DoD they are not actually doing very much basic research, it is more applied research, so that research means applied research. Then they follow on to exploratory development, advanced development and engineering development, and I think in some ways, although even those are liable to misinterpretation, at least in my mind in terms of the processes that are actually happening, those items do tend to give you a meaningful description. To me, I would certainly see advanced development as meaning an area of some technological risk, of some finite innovation content and so on, compared with engineering development, which is probably slightly lower technological risk than advanced development

and where the rate of innovation is probably less by definition.

73. The trouble is that in defence nothing stands still, does it? In those terms that you outline, would a mark 2 and a mark 3 and a mark 4 of a particular aero engine or particular aeroplane or missile be development?

A. I think I would see that example you give as engineering development in my terms and in US terms.

Chairman

74. And you would not want that included in research and development statistics?

A. No, I do not think I am really saying that at all. I think I am really saying that it is still research and development within the meaning of the term and I think it would be quite wrong to remove it to somewhere outside, because even in the very last stages of engineering development there is still an innovative content even if it is about manufacturing technology or something like that and, therefore, it obviously could have wider applications than purely that product. That would be my private definition about whether it is worth calling it R&D.

75. One of the main criticisms behind all these things was because all those three types of development are so expensive and, therefore, so much money goes into it, particularly in fields like electronics and aerospace, and because so much of what is spent in that is spent by the MoD, therefore when you look at the statistics as a whole that element distorts the whole purpose of having statistics?

A. Indeed.

76. It has been suggested to us that you actually remove development altogether and have research statistics as a test of innovation and development statistics for totally different purposes?

(*Sir Colin Fielding*) I think that is not an unreasonable point of view. My feeling is that, whatever you call it, I would certainly favour the idea of separating research and development, except that I think you have a very long period of common usage of the term "R&D", and the difficulty is that whatever you call it in the future people will still talk of "R&D". That is a problem. I think there is a lot to be said for it, if one can get away with it. I think my message much more is that development is a complex process, and it would be better in many respects if one could from a statistical point of view have some sub-definition of what that means so when looking at statistics you can see what that really means in relation to what you are trying to prove by the statistics. I think another aspect is that you have to look at what you decide to call it from the point of view of the conduct of business, because there is no doubt the conduct of business will drive people in companies to call things "R&D" or "development and research" which might have slightly different meanings, so that is another matter altogether. Perhaps all we need concern ourselves with is when that information becomes public and how you define it from then on. Yes, I think there is something to be said for separating R&D, if you could overcome the

2 March 1989]

SIR COLIN FIELDING

[Continued]

[Chairman *contd.*]

common usage factor which in all the years I have been involved I have never managed to see anybody change; "R&D" is something which slips off the tongue all the time.

Lord Nelson of Stafford

77. But you would not want to separate them too far?

(*Sir Colin Fielding*) No.

78. The measurement of wealth-creation based on R without any D is not going to measure very much except academically?

(*Sir Colin Fielding*) Without doubt, and that is why in many respects one is talking about R&D, because it is a linked process, a continuum in some ways.

Chairman

79. Do you think both the MoD and the firms which do extramural R&D could without difficulty split up development into the three categories you have suggested?

(*Sir Colin Fielding*) Yes, I think they could. I think they would all need some sort of guidance in definition terms which would be capable of interpretation, but it would not be impossible, and to a large extent a lot of the companies, certainly when I was in the MoD, already tended to talk of it as engineering development in the way I have just been describing it, and the way it is described in the United States, and for the very reason there is a danger people see engineering development as a huge innovative process which should be matched to basic research or applied research, which is not quite true. It is innovative but innovative in a different sense, and in using that information you have to apply it in a different way.

80. But, sticking to Frascati, you would stop at exploratory development and cut out the other two?

(*Sir Colin Fielding*) You might do. It may be sensible in a sense to build any changes into an extension of Frascati; in other words, to accept that it is a continuing process. You are talking of basic and applied research, and you are then going to talk of exploratory development, and then you are going to be talking of phases beyond that—whatever you decide to call them.

Lord Nelson of Stafford

81. But where would manufacturing development fit into it? If you take micro-electronics, the biggest effort has gone into developing new manufacturing equipment and new technology.

(*Sir Colin Fielding*) Yes, indeed.

82. Equally, under the American defence policy at one stage they include amongst their development contracts to industry substantial contracts for the development of production of manufacturing machinery?

(*Sir Colin Fielding*) And they still do?

83. Where would you put that?

(*Sir Colin Fielding*) I think that depending on the nature of it I would group that largely between

exploratory development and advanced development.

84. But you would include it in development?

(*Sir Colin Fielding*) Yes, because I see it as being applied to a very specific operation, whether it be in micro-electronics to process silicone or whether it be in methods of generating composite design and manufacturing processes for aircraft fuselages.

85. But Frascati does not cater for that?

(*Sir Colin Fielding*) In a way, this is perhaps the concern about Frascati. I think Frascati does do that if you read the words broadly enough. The problem you are left with is ambiguity about the meaning of basic and applied research; you are left unclear about what exploratory development really means.

Chairman

86. In your notes you say that in dealing with this problem methodologies need to be developed to break out this element of engineering development from exploratory development in a meaningful way which can be universally understood across boundaries. How do you suggest this should be done?

(*Sir Colin Fielding*) In a sense, probably the only thing one can do is attempt to solicit a sufficient corpus of view about what might be reasonable divisions between exploratory development at the left-hand end and production at the right-hand end, and, having derived what seem to be sensible and meaningful divisions, to try to define those in as clear a way as possible so anybody reading that in a company or government can thoroughly understand what it is one is trying to do. If one is going to talk of extension, that is probably the only way of tackling it. I think you have to take broad, informed wisdom, because it is not only about defence and it is not even about engineering in the manufacturing industry.

87. So, when we go to the second stage of our inquiry, and we think of sending out a letter to firms asking if they could give examples in their field of basic and applied research—very much the same as your examples—it might be sensible for us to ask them: Would it be possible in their field to break down development into your three categories?

(*Sir Colin Fielding*) Indeed, particularly in terms of external declaration, because in my experience companies do not always have that way of breaking down their own internal programmes from a management point of view, so they have to take what they are already doing to manage their programmes and distill that out into meeting the requirements of the statistics.

88. You heard at the tail end of our previous evidence a certain amount of scepticism about the value of these statistics and what they are used for. Do you feel there is a need to collect more and more detailed statistics so they can actually be used for useful purposes, whether by government or other people?

(*Sir Colin Fielding*) In spite of the difficulties and the kind of controversy they generate, I suppose I have to stick to a gut feeling it is right to try to do something meaningful if for no other reason than because at one level governments are trying to make

2 March 1989]

SIR COLIN FIELDING

[Continued]

[Chairman *contd.*]

policy decisions about what they should invest in R&D and in what sectors and what the wealth-creation possibilities within those sectors are. I think if you have not got that kind of information you really have no basis for beginning to debate that point. I suppose I hitch my personal waggon to the idea of saying the better you can make the definition of the information the more meaningful it will be in usage. I think that perhaps that has been the difficulty so far. I think it is important. It is difficult, but I think correspondingly when you start making comparisons across national boundaries, which again are critical to exactly those kinds of issues, it is important internationally to try to find some sort of agreed framework.

Lord Kearton

89. But it is not agreed by the witness that you measure everything by cost and not by quality? You can have 100 research workers with alpha pluses and hundreds with beta minus or gamma minus and everything else is the same and the results are completely different?

A. I think that is a very fair comment and I would not pretend that what I am saying is only one parameter of a rather difficult multidimensional problem, but it seems to me that the business of quantifying the quality of R&D, certainly internationally, is a phenomenally difficult exercise. I am not sure I understand even how to begin to do that, whereas I think so far one can tend to begin to equate financial investment. I think those who are moving in those sorts of scenes can often make some rather qualitative judgement about a comparison of the quality between R&D in, say, microelectronics in the US and R&D in microelectronics in Europe or something like that, and from that you may get meaningful arguments about, are we doing enough or are we not. That is the only thing I say, but I do accept your point. It is phenomenally difficult and it is a bit qualitative.

Baroness Lockwood

90. Do you think by applying your definitions it would perhaps be easier to judge, as it were, the quality of the research? For instance, one would probably get a better understanding of the division between actual research and development on your proposed definitions.

A. I think possibly it would not be so much perhaps quality but it would be interesting to make judgments. You might find that one particular sector or one particular country has a lot of its alleged R&D money invested right in manufacturing technologies and nothing in innovative R&D or product processes, which would be an interesting thought, whereas another country might have everything invested in product concept R&D and practically nothing in manufacturing technology or production technology. Again that is an interesting thought. These are some of the kinds of deductions one might make out of these sorts of situations and I think maybe those are less dependent on quality arguments than they are about missing links in the R&D chain, in fact.

Chairman

91. Do you find the subcategorisation in the Government review of primary purpose a valuable one? Could it be applied to Frascati as well, do you think?

A. I think it could, undoubtedly.

92. Do you think it would be a good thing to do?

A. Yes, I do. I think it would be very relevant because at least that is a further attempt to try to get in a sense another limb of a matrix, so to speak, as I see it, of understanding what that R&D is about, what it is addressing and so on. A lot of what we have been talking about so far has been addressing the product process but there are other kinds of R&D too which, of course, we have to take into account.

93. Do you think we ought to try and get an agreed international definition of strategic research and near-market research?

A. I think it would be helpful to have as good a definition as one can but there is a limit to how far it is worthwhile straining on that point because undoubtedly at the strategic research level there is probably a fairly reasonable international kind of feeling about what that all means and the chances are there would not be too much ambiguity. As I say, I think where the ambiguity lies is very much more as you go towards the product process and the product development as to what does it mean and what do the numbers mean within that particular bracket?

Lord Kearton: You get an awful lot of "copycat" research in industry. Some company develops a product of some kind and its rivals decide they will try to match it and they go through the literature and look at the plans, so there is a certain amount of industrial espionage in trying to match their product.

Baroness Lockwood: What would industrial espionage come under? Research?

Lord Kearton

94. We had better ask you the question, I think!

A. Yes, it is a difficult one and undoubtedly that sort of thing does happen, but when you have "copycat" research then you do have sheer duplication, which at the end of the day is not necessarily, in either national terms or international terms, making the impact you imagine by looking at the numbers. I would like to pick up another point that relates to what we have been saying. One of the concerns I have is the fact that a lot of the statistics we are talking about relate to Government expenditure and so on and, of course, that is the area that is reasonably easy to get at because it is in the public domain already. I think there is a very significant contribution by definition made by private industry to that particular portfolio and it is one where, while one is busy in a sense generating very highly refined data on Government expenditure, at the other end of the scale one has rather crude and inadequate data on industrial investment. Whilst I accept the reality that it is jolly difficult to define that and all the problems we are talking about in the public domain become even more difficult in the private domain, nevertheless it is a factor which can be a major distorting factor if you just treat public

2 March 1989]

SIR COLIN FIELDING

[Continued]

[Lord Kearton *contd.*]

expenditure as being the only characteristic to apply to wealth-creation and so on.

95. The definitions do seem to be very uncertain. I was 20-odd years or so in applied research and we built up an expenditure of very large sums indeed. It is surprising what a large amount of so-called R&D is effectively trouble-shooting, as it were *ad-hoc* investigations to make sure a turbine was not moving on its bearings and expansion of turbine blades did not foul the casing. There was an immense amount of money put into that but in the returns it was all down as R&D.

A. I think it is certainly a point of view and at the end of it all I think that is why I felt in talking about definitions one can perhaps generate a cock-shy at what might be a likely set of definitions, in a sense in the way I am talking this afternoon, and I will not pretend mine is a totally mature and refined and highly-launders situation at all. But to play those kinds of definitions across a wide range of industry and across a wide range of academic research institutions is a means of trying to flush out where are the funny situations to which these sorts of definitions do not apply very easily and how might we get better clarification even of those definitions. In other words, it is a starting process, I think, to getting a better answer.

Chairman

96. Would you like to comment on the machinery for collecting these statistics? Professor Pavitt covered this to a certain extent and he complained

that one of the problems was that the people collecting the statistics changed and then they changed and he quoted the example of an extraordinary shift in one year from mechanical engineering into the motor industry and back again. Do you think we should have somehow a more permanent machinery, whether it is linked to the Central Statistical Office or what, instead of a combination between the DTI and the Cabinet Office?

A. There is certainly much to be said for generating as much continuity as possible because the one single point I want to make there is that at least there, there may be the possibility of generating a kind of historical memory of just what these definitions mean and what is the use of these definitions, so that anybody in any doubt about the situation can come to this fountain head of knowledge about what it all means. I think that in itself would be useful because this is one of the problems, that the exploratory development onwards definition within Frascati is open to wide interpretation. It is easy from the point of view of those who are doing the R&D because anything that is not basic or applied research you put into exploratory development by definition, but when a third person looks at that information, what he or she makes of it is much more difficult to say.

Chairman: Thank you very much, Sir Colin. That has been very helpful and it will help to guide us as to whether we fire the second-stage rocket.

THURSDAY 23 NOVEMBER 1989

Present:

Carver, L (Chairman)
Chorley, L
Clitheroe, L
Dainton, L
Erroll of Hale, L

Flowers, L
Kearton, L
Shackleton, L
Sherfield, L

Memorandum by British Aerospace

Thank you for your letter of 24th October 1989. I am now pleased to provide a full reply to the questionnaire enclosed with your letter of 14th September.

BAe welcomes the opportunity to give evidence to the Select Committee on this important topic. Our response to the preliminary enquiry in February (*see page 57*), covered some of the same ground, and thus there may be some repetition. However, for completeness, this reply deals sequentially with all the questions from the "CBI version". As in our first response, we would claim that adequate investment in R&D is essential for a healthy UK manufacturing industry and that accurate quantification of the real investment in R&D, by both Government and industry, is important if policy is to be well founded.

Our detailed reply is as follows:—

Question 1

What definitions of R&D do companies use in their day-to-day operations? How do these differ from those used for the purpose of:

- (a) making returns to the DTI survey of industrial R&D;
- (b) compiling Annual Reports and Accounts?

BAe has not, in the past, required its Companies specifically to identify R&D strictly according to the Frascati definitions but action is in hand so to do. However, in presenting Technology and Business Plans, with their associated budgets, our companies provide a reasonably accurate identification of both company funded research and development according to Frascati. Our research work is almost entirely "Applied Research" and it is clearly differentiated from "Experimental Development" (known in BAe as Product Development) in the planning, management and financial processes. Thus, when dealing with company funded work, the BAe returns to DTI and the compilation of the Annual Report and Accounts are based on Frascati.

There are however problems associated with work performed by BAe under contract from MoD. In these cases, BAe had traditionally accepted MoD's own identification but recent analysis of several major development contracts has shown that many of the tasks covered did not contain the "appreciable element of novelty" which is at the heart of the Frascati philosophy. A BAe working party considered several established definitions of R&D including Frascati, the US DoD definitions, the Downy definitions for project management, and also generated a definition of "True R&D". This work showed that there was a reasonable equivalence between the definitions and we have concluded that, for the sake of overall consistency, to try to use Frascati as a universal standard and to interpret MoD contract work accordingly.

Question 2

What problems do companies experience in classifying their R&D spending for the purpose of:

- (a) making returns to the DTI survey of industrial R&D;
- (b) compiling Annual Reports and Accounts?

In financial terms, the key problem is the need to differentiate between R&D and other much more expensive downstream activities. The outstanding example is associated with MoD contract work, as described above. The BAe working party, subsequently supported by an SBAC study, indicated that based on a sample survey, only about 20 per cent of such MoD contract work qualified as R&D under the Frascati definition. This experience showed that a considerable amount of investigation, on an item by item basis, would be needed to give an accurate assessment of the extent to which there is an "appreciable element of novelty" in a major MoD contract. Thus we can only provide an intelligent estimate based on an overall engineering judgement of the nature of the work involved at any given stage of the development of the particular project.

*23 November 1989]**[Continued]**Question 3*

In your initial response to the Sub-Committee you stated that companies “vary in their degree of adherence to the Frascati definitions . . . while believing their variants are consistent with Frascati”. What is the degree of variability between the operating definitions of R&D used by companies within:

- (a) the same industrial sector
- (b) different industrial sectors

Within the UK aerospace industry there is a recent example. Following the BAe internal review, the same problem was put to the leading UK aerospace companies through SBAC and they were able to identify expenditures on “True R&D” following the BAe (Frascati like) definition and guidance. This suggests that the Frascati definitions are a reasonable basis for companies within a sector.

We have little direct evidence about comparisons between sectors.

Question 4

What explanatory notes or guidelines do companies use in interpreting the Frascati definitions? Are they adequate for this purpose? How well do companies understand the concept of an “appreciable element of novelty”, which is at the heart of the Frascati definitions?

The explanatory notes and guidelines for interpreting the Frascati definitions are quite comprehensive and they address the critical borderline cases such as prototypes. It is however a difficult subject and fine judgements may still be required. The notes are made available within BAe but in practice they may not be fully employed. A more concise and user friendly set of definitions and supporting documentation, which emphasises the concept of an “appreciable element of novelty”, would be an effective means of improving the situation.

Question 5

How good are existing industrial R&D statistics? What degree of subjectivity is involved when companies categorise their R&D spending? Is it possible to attach confidence limits to these figures, ie ± 5 per cent., 10 per cent. or 20 per cent? How reliable are apparent trends in the return from a particular source?

A number of specific examples have been analysed, particularly for major projects which dominate the costs, but the interpretation into an overall view involves fairly wide assumptions. It would not be possible to put reliable confidence limits to such subjective analysis.

Question 6

What factors limit the accuracy of R&D statistics? For example, it has been suggested to the Sub-Committee that the accuracy of industrial R&D statistics is affected by the failure to record the R&D activities of small firms? Are there any changes to the DTI survey of industrial R&D which you would recommend?

It is difficult for BAe to comment on the overall accuracy of UK statistics and the contribution from small firms except to refer again to the problems caused by the categorisation of MoD work and the corresponding uncertainty about the interpretation which industry makes when reporting on such contract work.

Question 7

Do the Frascati definitions provide a clear means of differentiating between:

- (a) basic and applied research

We have no strong views about the adequacy of Frascati in differentiating between different kinds of research. Clearly some identification and recognition of basic research is needed if only to help protect the existence of such work. All our research falls into the applied category.

- (b) research and development

The differentiation is clearly stated by Frascati and we are not aware of any problems in the five areas which are reference.

- (c) R&D and other related activities

This is the key interface with substantial increases in expenditure as R&D work builds up and evolves into downstream activities such as system integration and production. The Frascati definition and criteria are clear enough, understanding and interpretation are the crucial problems (See Question 4).

Our response to sub-questions (i), (ii), and (iii) are covered by our answers to Question 3 and for sub-question (iv) we have already described the problems which stem from MoD using a much broader definition of R&D which substantially overstates their investment in true R&D.

*23 November 1989]**[Continued]*

The question of international comparisons of R&D (v) is a very complex subject. An attempt at such a comparison was presented in the Appendix to the EIRMA lecture by Mr I R Yates on "Defence, Development and Economics". This drew attention to the many problems involved in making such international comparisons of Defence R&D and the many inconsistencies in the reporting by different countries, subsequently incorporated in the Annual Review comparisons. This analysis described reasonably comparable reporting to UK in the USA scene (explained further in Question 9), the need for substantial correction to German data, the lack of satisfactory data in Italy and the unusual R&D situation in Japan. None of the countries were reporting according to Frascati definitions, since their primary concerns were their differentiation between research, development and production for defence budgeting purposes.

Question 8

In your initial response to the Sub-Committee you stated that "fair comparison based on Frascati ought to be possible provided that a consistent approach was taken". Does this imply that the Frascati definitions are not consistently applied? If so how can this be improved? What will be the effect of the revision of SSAP13 on this situation?

In our view, Frascati definitions are not consistently applied. As previously stated, a more concise and user friendly set of definitions and supporting documentation would be a major improvement, and it would benefit the interpretation of SSAP13 revised. We would look to Government, specifically MoD, to make the major contribution to improving the quality of R&D statistics.

Question 9

What are the specific inadequacies of the Frascati definitions, and how might they be amended? For example, the OECD is considering supplementing the "basic" and "applied" research categories with a "strategic" research category. The US Department of Defense sub-divides "experimental development" into "exploratory", "advanced" and "engineering development" (Annex 2). Does industry perceive any advantage in the use of these, or other, categories to classify their R&D spending?

The key problem is the need to differentiate between R&D and the much more expensive downstream activities and so any changes to Frascati should be focused in this area.

There are no inadequacies in the Frascati definitions, as such, if they are used to identify the question of "appreciable novelty content". However, the Defence Ministries and consequently the defence industries have to go on with further engineering development to bring their development projects to a satisfactory production standard, including proving and qualification of this standard for release for military service use.

This division of development activities is reflected on the USA documentation mentioned in the question. This is the logical progression of Defence R&D project activity. We are not required to draw these divisions in our dealings MoD in UK.

Question 10

Taking, as examples, one or more companies from a number of different industrial sectors would you identify the activities, funded by those companies, which they would define as falling:

- (a) within the Frascati definition of (i) basic research, (ii) applied research, and (iii) experimental development;
- (b) outside the Frascati definition of R&D, but within the range of related activities which they may have difficulty in distinguishing from R&D.

In BAe studies, we have found that a review of the nature of the work covered by "Prototypes" or "Pre-Production" vehicles is the relevant focus for establishing an understanding and proper interpretation of R&D expenditure. We have discovered no simple formula but the "appreciable element of novelty" has been the dominant criteria. Thus, for aircraft, the first one or two prototypes might qualify but later aircraft will be used for work associated with integrating numerous sub-systems which would be repetitive in character and not novel. A similar but more extreme situation occurs in the development of motor cars and I suspect in the development of drugs.

Question 11

In the 'Annual Review of Government Funded R&D' there is an "apparent discrepancy" between the amount that government says it spends on R&D in industry and what industry says it receives from government. How does this situation arise and how can it be improved?

It is difficult for BAe to comment but we suspect that the main problem in industry lies in the lack of technical consideration which is given ie the replies emerge from the financial system without proper review

23 November 1989]

[Continued

and interpretation of the underlying work. We fear that the collection of accurate statistics will not command a high priority from busy technical managers.

We have already referred to the problems of MoD data, a problem which we believe is understood by MoD.

Question 12

It has been suggested that the number of scientifically and technically qualified personnel employed in R&D is a better indicator of R&D effort than is R&D spending. Do you agree?

We do not believe that the number of qualified staff employed on R&D would give a better indicator of R&D effort than R&D spend, for a number of reasons. R&D effort depends not only on the numbers of qualified staff and of the research and development facilities available to them. Also, companies may sub-contract research work elsewhere. Universities, and the relevant numbers of staff might not be readily identified. In the aerospace industry, some staff are employed on R&D within the Frascati definition and also on subsequent development activities; with problems in allocation of time to each. The use of qualified staff numbers would introduce further complexities in the comparison of R&D between different countries.

We have a similar problem in production, where it is often suggested to us that "man-hours" would more properly evaluate production effort. Again, this begs the definition of direct workers and indirect supporting workers, the machine tools and capital investment available to them. In the end, the overall cost is the only sensible applicable measure.

I trust the above is of assistance to you and look forward to appearing before the Sub-Committee on 23rd November 1989.

I. R. Yates

7th November 1989

Preliminary Memorandum by British Aerospace

Introduction

BAe welcomes the opportunity to give evidence to the Select Committee on this important topic. We consider that an adequate investment in R&D is essential for a healthy UK manufacturing industry and BAe businesses in particular. Accurate quantification of the real investment in R&D, by both Government and Industry, is important if policy is to be well founded and the Select Committee has correctly identified the need for a consistent and well understood definition of R&D. The following response addresses the three questions, and the sub-questions, posed in the letter to witnesses. We consider that the questions themselves are useful and would be appropriate for a wider survey. However, we also suggest that specific reference should be made to the value and clarity of the supporting explanatory notes which are needed for a proper interpretation of the Frascati definitions (see response to question 2).

I. Do you use the Frascati definitions in identifying R&D and differentiating it from other activities? If not, what definitions do you use?

BAe has not yet required its Aerospace Companies specifically to identify R&D strictly according to the Frascati definitions but in requiring the presentation of Technology Plans, Computing Plans and New Business Plans with their associated budgets there is a reasonably accurate identification of both research and development. Our research work is almost entirely "Applied Research" and it is clearly differentiated from "Experimental Development" (known in BAe as Product Development) in the planning, management and financial processes. Formal differentiation has stemmed from accounting procedures, such as the Frascati based SSAP 13, and those of our major customers such as MoD.

Whilst BAe has had no major problems in identifying company funded R&D, there are problems associated with work performed by BAe under contract from MoD. In these cases, BAe has traditionally accepted MoD's own identification but recent analysis of several major development contracts has shown that many of the tasks covered did not contain the "appreciable element of novelty" which is at the heart of the Frascati philosophy. A BAe working party considered several established definitions of R&D, set against the nature of the work involved in the development of several aerospace products. This has led to a proposed definition of the limit of true R&D to "correspond to a point where sufficient knowledge is available to proceed to a decision to initiate, with confidence, the design of a product but not necessarily to proceed to a production decision".

This corresponds to the Frascati definition, the end of the Advanced Development stage as defined by the US DoD and the end of feasibility and project definition for project management defined by Downey. This study created a better understanding within BAe and positive steps have been taken to work to a common standard as referenced in our 1987 Annual Report.

*23 November 1989]**[Continued]*

These issues are now being taken up within our Rover Company with a view to achieving a consistent and coherent approach across the Group.

II. Granted the Frascati definitions are the international standard, do they provide a consistent means of differentiating:

- (a) between R&D and other activities;
 - (b) between different kinds of research, and between research and development;
- for the purposes, in both cases, of:
- (i) compiling statistics of R&D activity within an industrial and/or scientific sector;
 - (ii) comparing R&D activity between industrial and/or scientific sectors;
 - (iii) comparing R&D in the civil and defence sectors in the United Kingdom;
 - (iv) international comparisons of R&D activity;
- and
- (v) compiling company accounts.

In financial terms, the key problem is to differentiate between R&D and other, much more expensive, downstream activities. The Frascati definitions are consistent but the problem lies in their interpretation. This is tackled in the body of the OECD report (ref The Measurement of Scientific and Technical Activities—Frascati Manual 1980) by discussion of the interfaces, such as the treatment of “prototypes” but this discussion runs into many pages. We suspect that most people involved in providing R&D data do not take the time and trouble to read, understand and take guidance from the notes supporting the definitions.

Turning to the particular areas of application (i) to (v), we can of course, only speak for our own experience and our perception of the situation in a relatively limited number of related areas.

a(i)

Within the aerospace industry, there is a recent example. Following the BAe internal review mentioned earlier, the same problem was put to the leading UK aerospace companies through the SBAC. They accepted the existence of the problem and were able to identify expenditure on True R&D following the BAe (Frascati like) definition and guidance. This suggests that the Frascati definitions are a reasonable basis for companies within a sector when the principles are fully understood.

a(ii)

We have little direct evidence about comparisons between sectors but our present programme of integrating Rover into BAe will no doubt soon give greater insight.

a(iii)

As mentioned above, there are major pitfalls in comparing R&D expenditure, as defined by MoD, with Frascati definitions used elsewhere. Our experience suggests that there are no fundamental reasons why fair comparison based on Frascati should not be made providing a consistent approach is taken.

a(iv)

International comparisons of R&D activities are made by OECD but we have had great difficulty in acquiring sufficient information about foreign interpretations to be confident about the accuracy of comparisons, particularly for defence expenditure. The detailed categorisation used by the US DoD is a major exception and we would be more confident in this case.

a(v)

Frascati definitions are the basis of SSAP 13 and it would be reasonable to continue to use Frascati in future.

(b)

We have no strong views about the adequacy of Frascati in differentiating between different kinds of research. Clearly some identification and recognition of “Basic Research” is needed, if only to help protect the existence of such work.

The differentiation between “research” and “development” is clearly stated by Frascati and we are not aware of any problems in the five areas which are referenced.

III. What therefore are the specific inadequacies of the Frascati definitions, and how might they be amended?

Inadequacies lie not so much in the Frascati definitions themselves but rather in the acceptance of their use (for example by MoD) and in their interpretation. The existing supporting documentation addresses the

23 November 1989]

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interface areas and the interpretation of the definitions quite well but it is a difficult subject which takes many pages. A more concise and "user friendly" set of definitions and supporting documentation is probably the most effective improvement which could be made.

It is important that the UK puts its own house in order, and if at all possible, the internationally agreed approach established by Frascati should be retained.

J. Arnall,

Head of R&D

23rd February 1989

Examination of Witnesses

MR IVAN R YATES, Deputy Chief Executive (Engineering) British Aerospace, MR J ARNALL, Head of R & D (BAe HQ), and DR W STEWART, Consultant to British Aerospace, Society of British Aerospace Companies, called in and examined.

Chairman

97. Mr Yates, we are very grateful to you and your colleagues for having come along to talk to us this afternoon and answer our questions and for the various pieces of paper you have sent us, including extracts from lectures you yourself have made, and Dr Stewart's paper. If I could just bring you up to date as to where we are, we started off with the study at the beginning of the year. It arose out of dissatisfaction which previous studies has caused in our mind about definitions of research and development and their use for either policy purposes or making comparisons either between industries or nationally or internationally. We spent the early part of our study trying to make certain we were asking the right questions. That took us a few months, and we had help from you and others in advising us as to what questions to ask. We sent out to 31 different organisations including industry, government departments, accountancy and others. We did not send out exactly the same questions to all concerned. The Sub-Committee then turned its attention to the greenhouse effect while the backroom boys tried to digest all the evidence we received. We have now reached the stage where we have looked at all this evidence and we want to tackle some major issues that arise out of this, in which we realise you have taken a great deal of interest, in particular the major question of the distortion caused by the MOD's figures. So perhaps you would like to introduce your colleagues and, if you wish, make a general statement before we ask questions.

(*Mr Yates*) If I may first introduce my colleagues, Dr Stewart who was with the MOD has now been helping in some of these activities over the last two or three years. Mr John Arnall of British Aerospace is the head of research and development. I understand from your remarks that you fully appreciate the difficulties; it is a rather complex subject and any attempt to produce meaningful apparently simple statistics can be very misleading. I got increasingly interested, partly for reasons of internal management in the company and the efficiency with which we did our research and development, and I tried to make comparisons with the competition but also recognised that the significant difference in the way the MOD recorded their costs, which was perfectly satisfactory for MOD purposes, did lead to traps if

you added it in simply to the rest of the civil sector, which thereby overstated the total research and development apparently in the United Kingdom. That worried me because I felt that we were not aware of a significant situation, when apparently there was a deficit in relation to other countries—similar countries—and it was really at that point, about three years ago, when we started to look into some of these things in some detail. Since then there have been a series of studies to which you referred. I think probably they have got nearly as far as is necessary. It is one of these situations—rather like trying to find the length of the periphery of the United Kingdom, when you start looking at finer and finer detail and you start worrying about individual pebbles on the beach—or wonder whether the chap in the lab making the tea is actually doing research and development or not. There is a point beyond which it is not worth going. I believe we have got to a good practical situation now where one can reasonably understand, where—although there are quite a lot more things, particularly in the civil sector, where we do not understand everything very well—it is much better. Perhaps that is an answer to your question.

98. Then do you think SSAP 13 is going to make a significant difference to the accuracy of our knowledge of the R & D going on in industry?

(*Mr Yates*) I think it will help, but it really addresses the profit and loss account of the company. So there would be two things missing from that, one of which could be costs of research and development which are counted under the overhead costs of the company and therefore do not appear. Secondly, it may not take account of research done under contract. For instance, in our case in British Aerospace many companies are under contract to the Ministry of Defence or even the DTI, so in that sense one would tend to understate it. But the Frascati definition is satisfactory, but SSAP 13 might miss out the points I have made.

99. If I am right SSAP 13 only asks for an overall statement of the R & D and does not expect it to be broken up into research and development.

(*Mr Yates*) No, I think there are two aspects, if I may. One is differentiation between research and development. I think it is important actually that differentiation is made, partly to understand the

23 November 1989]

MR IVAN R YATES, MR J ARNALL, DR W STEWART

[Continued]

[Chairman *contd.*]

breakdown—and it varies between industries. I think that is an important thing. Secondly, I believe the UK problem is, in fact, that there is not enough development and therefore you need to separate development from research to understand how much is done in relation to, say, similar countries. So I certainly do wish to see recommended a breakdown between the research and the development elements.

100. As I understand it, if you conform to SSAP 13 you do not necessarily do that?

(Mr Yates) No, I think you need to go beyond it really. I believe so.

Lord Chorley

101. Are you saying SSAP 13 is inadequate?

(Mr Yates) In two ways. It does not differentiate between the research and development, it aggregates them. Secondly, a company literally interpreting it might not, or would not, necessarily include the costs put into its overheads. For instance, the Ministry of Defence would allow certain charges into overheads which would not appear in the profit and loss account, so we would miss that element and so could understate it; likewise that which could be done under subcontract to the company—declaring under SSAP 13 would not necessarily put that in. In fact, it would not.

Chairman

102. If you look at the totals that industry gives, those include both R & D. You reckon from that you could judge the degree to which they were putting effort into innovation?

(Mr Yates) It is a very good indicator. There are others—if you have got the numbers employed in an area—but if you want a single best indicator I think the amount of money spent is the best.

103. I know when we talked to OECD they very much made the point that they wanted to try and find some way not just to judge input but to judge whether the output from R & D was actually producing the innovation expected. Is that a practical thing to do?

(Mr Yates) Extremely difficult, I think. You then get into a very fine degree of differentiation, for instance there is a difference between what I might call industry based on chemistry and industry based on physics. We are in the latter, which is manufacturing industry, and it is technologies which effectively form the building blocks for the ultimate product. That is why I think the ratio between research and development spend in those two types of industry are different, and I think you have to notice there are quite wide variations in the spend, if you take it as a percentage of sales or turnover, between say electronics, where research and development (like pharmaceuticals) can be in double figures, 10 per cent. plus, and other companies, such as Aerospace, where putting an aircraft together means you are putting together a lot of things like engines (which already have the R&D in the price when you buy them) so that tends, looking only at the aircraft manufacturers' expenditure, to understate the total R&D, and you have to be very careful about this.

104. Why does the city take fright if they see the R&D figure is high in the annual statement, which happened to Glaxo lately I understand?

(Mr Yates) I think there could be two elements to this really. It is generally understood the city does not like surprises, and you could say that suddenly came as a surprise and produced the reaction, or over-reaction. The other element is that generally speaking the whole, what I would call the development investment cycle—or process of doing research and then taking it forward to the beginnings of a product and then into development and then into manufacturing—is not really understood properly, either in its various parts or the amount of time you spend in each phase. Consequently, I think the return you get on investment is not properly understood and therefore we under-estimate, I think, as a nation the importance of making those investments and the growth which comes from it.

105. In spite of the fact we have all these clever young people who are supposed to have studied science at university going into the city?

(Mr Yates) Bringing their numeracy and ability to think, which is a great advantage to them. I tried to find a model of what I have just described in economics text books or in any of the schools of economics, and I could not find one, and I had to spend money on constructing this whole development investment cycle. Very often economists do not view research and development as an investment which leads to growth, but it comes in as a cost.

106. So it is the economists who need educating?

(Mr Yates) And we are spending a lot of time on that.

Lord Flowers

107. Not least the business schools?

(Mr Yates) Yes, indeed. If you look at most of the schools of economics they are mostly associated with social sciences or accountancy and not engineering.

Lord Dainton

108. Some research is insurance protection, is it not, in the sense that a firm becomes aware and ready to take advantage of other people's discoveries?

(Mr Yates) That is right, and that would increase the initial spend on research or even in the early development stage where you might wish to make one prototype of one thing if you wish to move out quickly.

109. The difficulty is knowing how to classify?

(Mr Yates) It would appear if a firm was normally reactive, it would do that and that would appear in its total sum of spend. If one found one was doing half as much as one's rivals, I would be worried.

Lord Shackleton

110. Take a working system, say, of your new aircraft, are you able in view of the various components (a) to say how much is production and (b) how much is R and how much is D? When it comes to an unsuccessful project, like the electronic equipment that was going into the Nimrod—I do not

23 November 1989]

MR IVAN R YATES, MR J ARNALL, DR W STEWART

[Continued]

[Lord Shackleton *contd.*]

know whether that is shown in the GEC accounts, perhaps it may be a profit to them because the Government presumably paid for it—are those figures remotely possibly available or established?

(*Mr Yates*) I think you would need to do two things. You would know from the Ministry of Defence's accounts how much was what you might properly call manufacturing, which is producing several sets at the same time. You would also know what the Ministry of Defence called research and development. The difficulty then comes that under that definition of development there would perhaps be a lot of repetitive work which is straight forward engineering which made it possible to do the subsequent production, and it is that bit which I think you need to take away, and call the parts or elements of research and development, and engineering (or pre-production engineering) and then you can move into full production. I think they can be obtained, yes. Separating out research from development, and that element of development from the Ministry of Defence definition, is somewhat judgmental. This is where you come back to interpreting the element of novelty from the Frascati definition. I think it can be done to reasonable accuracy.

Chairman

111. Let us turn to this major question of the problem which the MoD's R&D poses, both in the question of the enormous amount they list under development and also this discrepancy between what they spend on development and what the firms who are doing the research and development for them actually say they spend themselves. What do you think ought to be done to put this right?

(*Mr Yates*) I think if the Ministry of Defence contracts were interpreted by firms more clearly under headings which accounted for the type of work—for instance the American Department of Defense uses definitions which properly interpreted give us a fairly good handle on what we are looking for—that would be quite satisfactory. Equally, if we still left the UK Ministry of Defence with its broader definition, so long as one was fairly clear on each major project or major contract that which was innovative and that which was not, that point could be made by the contractor or the project officer, and then we could get this distinction quite clearly.

112. You think it would be done project by project?

(*Mr Yates*) I think so, because the ratio of research and development differs, and the amount of development work in each product differs. It would not be reasonable to apply a blanket scaling. In electronics you could be producing a black box or a total weapons system and the ratios change. In the SBAC study British Aerospace found they had a smaller percentage of the innovative, so-called, development part than the companies providing the equipment to them. That is understandable because they would put a lot of equipment into an aircraft and then fly the aircraft, and maybe they would be looking at one-twentieth or one-fiftieth of the total system being changed between flights, whereas the rest of it is doing nothing.

113. Is that not going to lead you down a frightfully complicated process because you have to look at each component and ask how much innovation is there in each chip?

(*Mr Yates*) It gets ridiculous and I get back to my problem. Exactly. You can get a sufficiently accurate one by looking at the contract level.

114. This would be done by both the procurement executive and by the firm to which the contract went?

(*Mr Yates*) I think if there is a set of definitions of the sort I have developed basically within British Aerospace, it could be applied by the aerospace industry and the defence industry. I think that could be accepted by the Ministry of Defence and one could quite readily define for most of the contracts, nearly all contracts, how much money came into each of the categories.

115. One of the arguments put forward against having a lot of sub-divisions is that this involves a great deal of subjective judgment about which division you put them into.

(*Mr Yates*) Well, that is inevitable, I think. It is a degree of so-called accuracy with which you strive. If you go for getting three-quarters of the truth you get it quite readily; if you try and go for 99 percent you find you are forever arguing. That would be completely nugatory. I am sure in a practical sense we can get as close as we wish. We are looking for quite a large discrepancy, I believe 30 percent odd. If you can get that down to 5 or 10 percent, we have got as close as we need.

116. You therefore think it is possible by adopting the right methodology to produce more or less accurate figures of the Ministry of Defence on research and development which then, as it were, correspond more or less to the general Frascati definitions and more or less correspond to the same definitions in the civil field and, therefore, would give a true picture of what government research and development really is and a true picture for international comparisons?

(*Mr Yates*) Yes, I do. I believe it can be done without too great a burden.

117. Why does not the Ministry of Defence do it then?

(*Mr Yates*) I think for their own management and accounting purposes they do not need to. It is really a question of the national good, if you like.

Lord Chorley

118. Why does not the DTI do it? I understand they are responsible for making the returns for the OECD and they say they follow Frascati.

(*Mr Yates*) They do follow Frascati.

119. But they ignore the novelty point?

(*Mr Yates*) No, they get returns from the companies and the companies, in effect, in giving figures to DTI have made the judgment as to what is novel and what is not, and you do actually get differences between what MOD say they are paying and what the industry says it is receiving under their interpretation of Frascati, which tends to reinforce the point I am making. There is a difference.

23 November 1989]

MR IVAN R YATES, MR J ARNALL, DR W STEWART

[Continued]

Chairman

120. But the distortion is both something that matters and that can be cured?

(Mr Yates) Yes.

121. We should grill the Ministry of Defence when we take evidence from them as to why they are not doing it?

(Mr Yates) Yes, if I might suggest, how can they readily do it, how easily can they do it?

Lord Flowers

122. Could I ask Mr Yates about motivations for all this. The MOD for its own purposes does it that way, that satisfies its purpose, whatever that is. I suppose it only matters that they do not do it the way the rest of us do it because people go round making statements, giving lectures and inventing policies if they happen to be Ministers, on the basis that the United Kingdom does or does not do as much R & D or whatever as other countries. Then it becomes a matter of some importance, but for another reason.

(Mr Yates) Yes.

123. So there is only any point in trying to get these classifications more accurate if there is a particular purpose that one has in mind, is there not?

(Mr Yates) Yes.

124. So really in what you have been doing to try and help sort this out what has been your purpose?

(Mr Yates) I believe that the way the figures are published does tend to overstate the total apparent research and development in the United Kingdom for the reasons I have said, and that what appears as about, let us say, 2.3 per cent. of gross national produce as R & D (which is in the same category as France, Germany, the United States and Japan) is actually, if you make the correction I believe is necessary, rather less than 2 per cent.

Lord Kearton

125. You draw the conclusion in your paper that we need to spend £1 billion plus a year on civil research and development.

(Mr Yates) Because if you take the quoted MOD expenditure of £2.3 billion and you then do your sums you end up with £1.2 billion missing.

Lord Flowers

126. Your motive is in the context of trying to get more money spent on research and development?

(Mr Yates) Yes.

Lord Shackleton

127. In order to get accuracy in the published figures. This is really where we come in.

(Mr Yates) Yes.

Chairman

128. How important do you think it is that the figures should reveal what is called Knowledge and Technology Transfer Potential, or KTTP? Technology transfer is obviously frightfully interesting but how important is it to see that the returns do show that?

(Mr Yates) I think it is perhaps going to a level of accuracy or attempted accuracy which is perhaps unnecessary. It is an interesting concept and I think in some ways it is an important one. It depends what you are looking for.

Lord Kearton

129. I thought it was self-defence on the part of the industry, they were keen to know how much national effort because they wanted to show there was a spinoff on the civil side.

(Mr Yates) Well, interestingly enough it was an ACOST concept, not an industry concept, and it was in the context of the ACOST sub-committee on which I was. There was an attempt to find out what could be transferred from the Ministry of Defence or had potential for transfer into the civil sector—hence this definition.

130. In your own paper it is very low in your own view. I think you quote a figure of 20 per cent. or so.

(Mr Yates) That is the ACOST figure really. I should point out it is a two-way business. There is civil technology from modern computers and software which transfers back into the Ministry of Defence. It is not all one-way.

Chairman

131. The OECD I think are considering this. Do you think something should be added to the existing Frascati definition to include technology transfer?

(Mr Yates) No. It depends on your objective. I think we should not regard KTTP as being an alternative to the Frascati definition. I think that is clear. Nor in a sense is it just a refinement of it. In a sense it addresses another question. If you want to keep the national statistics fairly clear, then I think one would look to the Frascati type definition, the innovation, basically the level of novelty, and that is clear enough, I think, and is probably sufficient for practical purposes. If you then need to go for some other reason to see what potential for knowledge or technology transfer between sectors is, then you go to the KTTP thing, but I would not think it necessary to apply it across all the statistics, which would be the implication of going to that solution.

132. You said in your report that you tried to turn your own companies within British Aerospace into a greater conformity with Frascati. Why did you do this?

(Mr Yates) Two reasons. I think one wanted basically to improve the efficiency of the management of research and development. Secondly, it was to keep track of that which was generated internally out of profits, and that which came from contracts in the Ministry of Defence. So in a sense I was also in that part of it trying to track through the potential KTTP.

133. Have you found difficulty or have the companies themselves found difficulty in doing this?

(Mr Yates) Not really, no. What you need is some guidelines to interpret the Frascati definition—it needs perhaps to be a little more user-friendly, if I may say that, and you need to explain what you mean in more homely terms.

134. They give a fairly extensive listing of examples, do they not? Why are they not using them?

23 November 1989]

MR IVAN R YATES, MR J ARNALL, DR W STEWART

[Continued]

[Chairman *contd.*]

(*Mr Yates*) My colleague was remarking that they are almost too long. People really tend best to understand by example and, for instance, just if I may for a second, if you have a new aircraft and are going to have to build 15 of them to develop the whole weapons system, perhaps the first one or two might be regarded as innovative, but with the third, fourth and fifth you might say "Let's forget it, there is a lot of repetition in this". That is a very crude definition. I would say interpret Frascati to mean the first two, but ignore the rest.

Lord Chorley

135. Surely that is what Frascati does say.

(*Mr Yates*) That is so. I am not adding anything to Frascati really. It is simply to help interpret it.

136. They say that in so many words, if I recall the passage. It might not be the sort of book people want to read at bedtime. Would it help if there was child's guide to case law, examples?

(*Mr Yates*) I think it depends. If you were a large company with a lot of people you might be prepared to have that. If it is a small company, you may find the accountant or whoever it is who has to do it does not want to read through all those cases.

Lord Shackleton

137. Do you think the other countries' figures in OECD are as impaired as the figures we produce nationally, or do you think they get it right?

(*Mr Yates*) From what I have said the American figures appear by categorisation to be very nearly accurate and directly useful. I would like to ask Dr Stewart to comment on this because he did a very deep analysis of this and tried to make the corrections, and once you have made the corrections he has made, the ultimate figures are right. But it is the sources of funding which is important, as well as the definition.

(*Dr Stewart*) I think the basic problem is that the OECD collect these figures without too much examination of the basis on which the figures were provided. They are provided by government departments in each of the countries and, in the same way as we have this problem, if you really want a total by Frascati definition, you have to take every single item and go through it and evaluate it and add them all up; the Ministries of Defence are not really prepared to do that. The second main subject is what is it you want to compare. You have, for example, in comparing the UK with Germany, first of all a complete slice of nuclear work which the Germans do not have. Now do we want to compare total defence R&D or do we want to compare the non-nuclear content of it? The third main point is that each country is very differently organised, generally for historic reasons and for their own particular purposes. Again in the case of Germany, where they have for historical reasons generated an arrangement for R&D which is largely funded by ministries other than the Ministry of Defence, you find a different type of comparison being drawn. Even if you go down to quite specific examples, work which is almost identical in the two countries will be funded by the MOD in this country but will be funded by the

Ministry of Research and Technology in Germany under what is nominally a civil heading because it does not appear under the Defence Budget. So it is trying to get rid of all these different approaches to things, to try and get at the comparable data we are really looking for. You are looking at two basic things, one is the innovative part of it, which is where all the germs of the ideas come from, and the second is how you exploit these. When you look at different countries' industries, we have a complete indigenous industry in this country in many areas—aircraft is one—whereas in Germany they have mainly been involved in collaborative projects in advance technology. So the split between what is the innovative side of the thing and what is the exploitation of it is quite different in the two countries. At the end of the day you have to ask, what is the purpose of the comparison, and you get a very different answer depending on what you want to utilise the data for.

Chairman

138. Strategic research is being used increasingly as a term in different fields, and I know the OECD are considering whether or not Frascati should be altered to include strategic research. Do you think there should be a new definition which differentiates between strategic, basic and applied, or is the answer to have different categorisations of applied, or not to have any change at all?

(*Mr Yates*) I am inclined to not press for a change myself because I think there are two elements to this. It could be confusing if one had a further set of definitions, and the interface between the sectors of research gives rise to confusion. I believe at the moment the overwhelming problem in the UK is not to get a precise definition of the various types of research, but trying to find out more accurately just how much development is done, or not done, as the case may be. That is the overwhelming priority, frankly.

139. Are there industries or sectors of civil industry which, as it were, commit the same crime as the Ministry of Defence in classifying things as development which have not got much innovative content? Can you compare a field in which the Ministry of Defence is particularly guilty of this and a field outside which is not guilty of it or goes the same way?

(*Mr Yates*) Yes, I think there might be examples. I would be very wary of associating myself with the word "guilty" with regard to the Ministry of Defence! It is perfectly satisfactory for their purposes, what is distorting is when others add them together. I think if there is an element of trials—field trials, say, with drugs which may go on for years—they could well be in this category. I am not going on very great evidence but I suspect the degree of distortion is less than in the case of the Ministry of Defence because by nature the work is smaller, so it is a smaller proportion of their total research and development than the Ministry's non-innovative R&D is as a proportion of their total R&D.

140. In the civil aircraft field, in developing a civil aircraft, do you not find difficulties in deciding where

23 November 1989]

MR IVAN R YATES, MR J ARNALL, DR W STEWART

[Continued]

[Chairman *contd.*]

the innovative element begins or stops, and in the development of a military aircraft you would not have any difficulty in agreeing with the Ministry of Defence where that might be?

(*Mr Yates*) No, I do not think there would be any undue difficulty in either case. It is a question, as Lord Flowers says, of motivation. If you want an acceptable definition, it is there.

141. The thing I do not really understand is called civil aviation launch aid, which is included as R&D. Would you like to comment on that?

(*Mr Yates*) Generally speaking, it is that part of the total which can strictly be called research and development, for which the companies are responsible, and that would be the design and manufacture of the first aircraft, but particularly the design and some of the flying which is normally written-off straight out of profit by its nature and becomes a very large figure for a period of three, four, five years, and which would so distort the profit and loss account of the company as perhaps to make it vulnerable in terms of the stock market. Launch aid is being conceived as a means of helping a company through that difficulty, being somewhat simplistic.

Lord Kearton

142. It is recoverable, is it not?

(*Mr Yates*) Yes, it is. I was going to say, it is then recovered as a levy on the product.

Chairman

143. As development charges are, are they not?

(*Mr Yates*) Yes, if you sell it. There is a fairly complex accounting procedure which goes on, because in civil aircraft the actual manufacturing cost of the built aircraft is based on an average and it comes down as you build more, and you normally capitalise that element of extra cost and amortise it over the whole run of aircraft, as indeed the tooling which goes with the manufacturing is usually capitalised and amortised.

144. So you are not getting a distortion of R&D definitions in this?

(*Mr Yates*) Not of definitions, but you would have to be quite clear that the part of a company's R&D which was removed from its bottom line by the presence of launch aid was added back in if you want a financial statement of the research and development done by that company at any one time.

Lord Kearton

145. Do you know whether the Government classes launch aid as part of its R&D?

(*Mr Arnall*) It appears in all the statistics I have seen, so I suspect it does.

146. That is cheating!

(*Mr Arnall*) It is, yes!

Chairman

147. Nobody is guilty, and we do not have cheats!

(*Mr Yates*) It would be a distortion if the company included that total R & D and the launch aid appeared from the DTI, that would be double

counting. It would be equally wrong if neither put it in; it only has to appear once.

148. One of the things that comes out of all the replies we have received is that returns of research and development in industry exclude firms below a certain size. Another thing which comes out is that a very large number of these small firms are ones which have a very high R & D content in their work. Do you think that there is a distortion by the exclusion of small firms or is the total not significant enough?

(*Mr Yates*) I believe the bulk of the R & D tends to be done by the larger companies and the general perception is that the exclusion of the small firms perhaps does not grossly distort the national figure, but I agree it would tend to understate it. But I am in no position to put a figure to it.

149. If you subcontract small firms, then that does occur.

(*Mr Yates*) It would appear on our books if they did R & D for us. The difficulty is, I think, at small firm level—and in relation to larger firms they may even go through an intermediate company—to track some of these.

Lord Kearton

150. We are largely concerned with research promoting economic wellbeing and growth. On the basis of Dr Stewart's interesting paper we would get a much better international comparison if you just left out defence R & D—I see Dr Stewart is agreeing.

(*Mr Yates*) The thing that emerges is that the United Kingdom does not appear to do enough civil research and development in industry.

Chairman

151. Would it be a good idea to exclude defence R & D from all international comparisons?

(*Mr Yates*) I am sorry to say that it depends what you are looking for, because in the United Kingdom, for instance, the defence R & D is actually an industry which has a very strong positive balance of payments and therefore —

152. The whole export sales side?

(*Mr Yates*) That is not by accident, because there has been a very strong and consistent R & D pattern to the aerospace and defence industries for decades.

Lord Kearton

153. Very true. Would you just remind us what is the surplus on exports?

(*Mr Yates*) The aerospace industry net of imports is about 2 billion, and exports about 6 billion.

Chairman

154. I do not know whether you have subsidiaries in Canada—and I think Australia has the same system—where there are tax remissions on R & D and therefore the taxmen get into the business of defining R & D very carefully. Has that been a complicated process or has that caused problems, do you know?

(*Mr Yates*) We have a subsidiary in Australia which does research and development. I think locally

23 November 1989]

MR IVAN R YATES, MR J ARNALL, DR W STEWART

[Continued

[Chairman *contd.*]

it is not too much of a difficulty. Given the level of definition which we have been discussing today, for instance, I think that would be perfectly adequate as a basis on which one could base a tax system. The Germans and the French also I believe have had basically tax alleviation systems of a different type, but I would honestly believe the level we are talking about, using properly interpreted Frascati, would be a perfectly adequate basis for such a system.

155. If we could just get back again to this, we are going to take evidence from the Ministry of Defence. Where do you think the major distortion comes? Is it in the aerospace field? Is it in the naval field? In what field is it—or is it in all fields?

(*Mr Yates*) From the analysis we did and the cross-check from the British expenditure with the American, which is more clear about its definition, we came to the conclusion that the distortions were of the same order of magnitude in all three categories, land, air and sea. It is not confined to any one.

Lord Erroll of Hale

156. I would like to put it the other way around. Supposing you did not have this elaborate statistical exercise at all, would you regret its absence? Would you have any suggestions as to what might be put in the place of the present system? It cannot be wholly bad, on the other hand it does not appear to be wholly good, because of all the complications which arise. Could this Committee spend a little time re-appraising the whole system and possibly suggesting another system? Would you welcome such a proposal or would you say it is not worth the effort, particularly if you were on this Committee?

(*Mr Yates*) I use the word motivation again! I think it is difficult to conceive of a set of definitions which is much better than the Frascati ones. That would be the basis of anything I would go for. As to whether it is all worthwhile anyway, which I suspect was where you started, I think if the UK had a growth of its GNP which was the same over a long period of time as other countries and that we had a manufacturing base that was nearer to 30 per cent of the GNP than 20 per cent, I would not be very worried about it. But in fact, given that I believe there is an overstatement error, by accident, of the R&D and that research and development is a great driver particularly of high technology industries, and it is their growth which is crucial to the growth of the modern economy, I think it is very important to understand the process. Therefore I greatly welcome what your Lordships are doing and I think it is important to pursue it.

Lord Kearton

157. The lack of civil R&D is a symptom really?

(*Mr Yates*) Yes, it is.

Lord Clitheroe

158. There is a problem of course that as far as the MOD is concerned in producing these statistics, there is some desire to show there is a lot of research and development going on in the UK, and there is a problem on the other side for many companies I would suggest because if they show very high numbers of R&D they then become much more vulnerable, their profits are down and they look on the whole not too good. So there is an understandable difference between the numbers which are produced, and perhaps the actual situation is not all bad.

(*Mr Yates*) There must be pressures in different areas to under-record or over-record, or wish to do so. I believe the distortions are significant enough because the MOD figure is quite large and I am talking about £1 billion of R&D that is not done in the UK that we wish was done. That is so significant that I think it is important to pursue it. Once that is redressed you can be much more relaxed about some of the details, the minutiae, of the definitions and so on.

Lord Kearton

159. Now that Austin Rover is part of the Aerospace group, have you had a chance to look at the research and development activities of Austin Rover?

(*Mr Yates*) Yes.

160. What is your opinion of the work that Bhattacharyya is doing at Warwick?

(*Mr Yates*) He has obviously made a lot of significant contributions there but the pattern of research and development in the automotive industry in their published accounts is different again. So that is another distortion one has to watch out for. The other thing is that the automotive industry is a mature industry in the technological sense, so it is incrementally improving, steadily by a very creditable amount, and a lot of the improvements come from manufacturing technology, and not just from new products, which is also often over-looked. That is true throughout most of the industry and a great deal of work has been done in Rover not only by Bhattacharyya but also with contacts with Honda and a lot of people.

Chairman] Mr Yates, I thank you and your colleagues very much indeed for answering our questions so clearly and helpfully; it will be of enormous help to us as we proceed on our study and advance towards confrontation with the Ministry of Defence! Thank you.

THURSDAY 7 DECEMBER 1989

Present:

Carver, L. (Chairman)
Clitheroe, L.
Errol of Hale, L.

Kearton, L.
Nelson of Stafford, L.
Sherfield, L.

Memorandum by the Confederation of British Industry

As I have indicated, we have now consulted our Research and Manufacturing Committee on the enquiry/survey the Sub-Committee is proposing to conduct on the definitions of R&D, and can offer the following preliminary comments, based on members' responses.

In addition to commenting generally on the survey itself, one or two members made substantive replies to us on the survey questions themselves. In view of the discussion on this matter which is to take place at our Committee's next meeting on 4 April, at which we suggest that I hold back these comments, to form part of a more widely representative CBI submission to the enquiry to be prepared following that meeting.

What was clear from members' responses to our initial trawl of opinion was that companies do vary in the degree of their adherence to the Frascati definitions when defining, managing and believing by and large that their variants are consistent, ultimately, with Frascati.

On the details of the proposed survey itself, members generally welcomed the Select Committee's initiative in seeking to clarify the meanings of terms used in R&D to facilitate more useful exchange and comparisons across scientific and industrial activities. In principle, respondents felt that fair comparison based on Frascati ought to be possible provided that a consistent approach was taken. Consistent and well understood definitions of R&D, to allow for accurate quantification of the investment in R&D by industry and by Government, were thought to be important of a policy in this area was to be well founded.

Members agreed that the questions posed did broadly address the relevant issues and were appropriate for a wider survey. Taking up this point about 'well founded policy' it was, however, suggested that the Sub-Committee might usefully go further and consider whether R&D spend ought in fact to be widely regarded as a measure of innovation activity, given the often poor correlation between R&D expenditure and successfully exploited technological progress. R&D being only a partial measure of inputs to the innovation process, ideally what was required was a total view of inputs to the process, and how effectively they are combined.

It was suggested to us that many companies providing R&D data did not always make adequate reference to the explanatory notes supporting the present definitions, thus introducing unwarranted inconsistency, and that specific mention should be made of this specifically to evaluate the difficulties encountered by providers of R&D data and to give the Sub-Committee some indication of their accuracy/reliability. It was felt that this might, but might not, necessarily surface in their answers to the present set of questions.

I hope you find our Committee members' preliminary thoughts in this area helpful, and hope we will have the opportunity at the 4 April meeting to discuss the issues with your team in more depth.

Anne C Humberstone (Miss)
Secretary, Research and Manufacturing Committee

15th March 1989

Letter from the Confederation of British Industry

Following your letter of 19th May 1989, we wrote to over two hundred of our members known to be involved in R&D. To date we have received some thirty replies, and have again discussed the matter with our Research & Manufacturing Committee. On this basis we can offer the following response to your questionnaire:

1. The definitions of R&D used by companies in their day-to-day operations tend to be based on Frascati, but place greater emphasis on internal budget/departmental responsibilities. These operational definitions are normally used when responding to the DTI surveys. However, many companies clearly also include expenditure on other activities such as technical services and product development for the purpose of Annual Reports and Accounts. Presumably the revision of SSAP13 will eliminate this discrepancy in future company accounts;

7 December 1989]

[Continued

2. In general companies experience few problems in making returns to the DTI surveys, as operational definitions of R&D are normally used. However, several companies suggested that the DTI should be more specific regarding the source and use of expenditure for R&D in order to minimise the source and use of expenditure for R&D in order to minimise errors due to double reporting, e.g., contracted out R&D being reported by both the contracting company and contractor;
3. Operational definitions used by companies are normally based on Frascati, but often detailed guidelines to interpretation are provided by parent companies or trade associations, e.g. those produced by the Association of the British Pharmaceutical Industry (APBI), and the European Industrial Research Management Association (EIRMA). As a result statistics for R&D spending are more consistent within specific industrial sectors than across different industries;
4. As noted above, many companies rely on industry-specific guidelines provided by trade association or parent companies rather than the more general explanatory notes provided in the Frascati manual. Several companies believed that the Frascati guidelines were too abstract and biased toward university-based rather than industrial R&D. Most companies understood the concept of "an appreciable element of novelty", but one respondent felt that this was a poor criterion for distinguishing R&D from related activities, as subsequent product and process development may also involve 'an appreciable element of novelty';
5. The majority of companies believe that R&D statistics within specific companies and industrial sectors are accurate to within $\pm 10\%$, but statistics across different sectors and countries are generally considered to be less comparable, estimates of the variability being as high as $\pm 5\%$. However, a few respondents felt that attaching confidence levels to R&D statistics might further undermine their usefulness as an indicator of innovative activity;
6. As suggested by the above, a degree of subjectivity is involved in categorizing R&D expenditure and this will limit the accuracy of R&D statistics. Two other factors may also affect the accuracy of statistics: the double reporting of contracted out R&D, as noted in (2); the non-reporting of the R&D activities of small companies. Typically small companies have no formal R&D staff or expenditure, and such activities are normally lost in more general design work, and product and process engineering;
7. Few companies appear to experience any difficulty differentiating between basic and applied research as defined by Frascati, largely because very little basic research is conducted by industry "without any particular application or use in view"; thus by definition almost all industrial research is "applied". True "basic" research is mainly conducted in the public sector. Similarly most companies appear to have no problem distinguishing between research and development, but a few respondents were unhappy about the borderline between acquiring new knowledge and applying existing knowledge used by Frascati. However, by far the greatest problem companies experience with Frascati is differentiating between "experimental development" and subsequent product and process development, particularly in industries where the production of prototypes is not common practice. As a result, in many cases such "experimental development" is not reported in R&D statistics. In contrast companies from several different sectors stated that almost all defence contract work is normally counted as R&D by the MoD, although much of this is essentially product development, involving no "appreciable element of novelty";
8. Definitions of R&D appear to be consistently applied within industrial sectors, but greater variability may exist between different sectors. In order to improve matters it would be helpful if Frascati included industry-specific guidelines for interpretation, similar to those currently provided by various trade associations and other bodies. The revision of SSAP13 may improve the accuracy of R&D expenditure reported in company accounts, but is unlikely to have any significant effect on compatibility of statistics across sectors without such additional guidelines;
9. With the exceptions noted in (7) above, most companies believe that the existing Frascati definitions are clear and concise, and that the main problem is the generality of the explanatory notes and guidelines. There is widespread agreement that further subdivision of these definitions would confuse rather than clarify interpretation. However, several companies believed that "strategic research" might be more appropriate than the existing category of "basic research" and the condition that such work is "without any particular application or use in view" revised accordingly. It was also suggested that the inclusion of some reference to timescales, persons responsible, location of activities and probability of success might help interpretation of the existing definitions;

7 December 1989]

[Continued

10. Examples of activities falling under the various headings are:

<i>Example</i>	<i>Basic Research</i>	<i>Applied Research</i>	<i>Experimental Development</i>	<i>Other related activities</i>
Pharmaceuticals	Identification of new chemical entities in existing fields of interest	Synthesis, extraction, biological and pharmacological testing	Non-routine safety evaluation, pharmacy and clinical evaluation of new products	
Electronics (TV)	Work on image processing	Coding algorithms and writing software	Experimental hardware	Subsequent product and process development
Composite materials	Study of properties of new materials and failure mechanisms	Work on different joint configurations and structures	Application of results to specific products	
Gas appliances	Study of combustion processes	Design of new gas burners	Prototype gas appliances	Technical support in the field and safety testing
Machine Tools	Determine process and code software	Application and preparation of machinery data	Develop a specific tool and apply to more complex machining operations	
Scientific instruments	None	Study of lasers optical filters and detectors	Design and manufacture of prototype instrument	Develop new range of devices
Polymers	None	Convert existing polymers to new derivatives	Apply new materials to produce and test durability	

11. The treatment of VAT and profits on defence contracts, the broader definition of R&D commonly adopted by the MoD for contract work, and the more general problem of sub-contractors failing to correctly identify funds originating from the Government all contribute to the "apparent discrepancy" referred to. To help overcome this problem the MoD could adopt definitions of R&D closer to those used in industry, and the DTI survey could attempt to identify the original source as well as use of R&D expenditure;
12. Companies recognise that expenditure on R&D is an imperfect measure of innovative activity, particularly for the purposes of historical or international comparisons because of the effect of exchange rates, inflation, variations in the cost of personnel and so on. However, there is no widespread support for the idea of using the number of scientifically and technically qualified employees instead. This is because many companies, especially smaller enterprises, have no staff fully employed in R&D activities, and other companies rely heavily on work carried out in universities and research organisations. Furthermore, the labour—and capital—intensity of R&D varies across industrial sectors. Therefore on balance, the number of scientific and technical employees should only be used to complement, rather than replace expenditure on R&D as an indicator of commitment to innovation.

I hope that you find our members' experience and views on this matter helpful, and we will await the outcome of the Sub-Committee's enquiry with interest.

Joseph Tidd
Technology Group
 19th July 1989

Examination of Witnesses

DR JOE TIDD, Technology Group, CBI and DR G J K ACRES, Director of Corporate Development Johnson Matthey PLC, examined.

Chairman

161. Dr Tidd and Dr Acres, thank you very much for coming along today to help us in our inquiry with the views of the CBI. Thank you, Dr Tidd, for the letter you sent us on 19th July which was extremely helpful. If I could just bring you up to date as to where we are. We started off this inquiry at the beginning of the year because previous studies we

had done had left the Committee really very dissatisfied with the figures that were produced from the various sources, both for Government expenditure on research and development and on the accuracy or otherwise of the expenditure by industry. So we set about trying to see whether something ought to be done about this and if so what. The first few months of the year were devoted to trying to make certain with your help and with others' help

7 December 1989]

DR JOE TIDD, DR G J K ACRES

[Continued

[Chairman *contd.*]

that we were asking the right questions. We then sent out a list of questions to 31 different organisations and at that time the sub-committee turned its attention to another subject, the greenhouse effect. We have now come back to this after having had all the answers to the questions in writing which have been worked on and digested. We are now trying to deal with the main points and we have not yet really tackled the Ministry of Defence. I do not know whether you would like to make some opening statement. Perhaps you could tell us just how important you think it is that definitions of R&D spending should be more accurate than perhaps they are today. First of all, that the definition should be right and that the revisions to them should be more accurate than they are because one has to ask oneself the question: for what purpose are we collecting all these figures and that will determine whether they are satisfactory or not. Perhaps you could give your views on that and finish up by saying whether you think the SSAP13 will make a significant difference to the accuracy of public knowledge of the research and development going on in industry?

(*Dr Tidd*) The first thing is I think we would all agree that R&D is just one element of innovation or industrial innovation. There is only a tenuous link between R&D and competitiveness. It is not established in academia if there is any direct link. I think we all suspect intuitively there is a link and that link is probably the process of innovation. Again you are aware the OECD identifies seven stages in the innovation process but of those traditionally the only one you can measure easily (and it is still not easy to measure that) is R&D and one of the others is the number of scientific and technically trained personnel which OECD also ask for. These are two factors which are easy to quantify if not to define. In the case of R&D, yes measuring R&D is important therefore it follows that the definition should be as consistent as possible for the sake of international comparisons and comparisons across sectors but I think if our remit is to examine that question that is fine and we can discuss that. Perhaps a more important question is trying to get a handle on how important innovation is and measuring activity in that area; that is very difficult. We appreciate the initiative to try and improve the consistency of R&D and that is very important. It is only one factor, we believe, in the whole process of innovation. We feel having established R&D expenditure we need to move on perhaps and start looking at a broader picture of innovation, the general process of development, things like marketing, all these things that are in the same process and I think it is perhaps artificial to look at that one element in isolation. I am not sure whether we need to broaden the discussion or remit or focus on the definition of R&D. I think it is a worthwhile remit. Having said that, we believe in this country at least it is important to get across to decision makers there is more to innovation than R&D. Historically, the UK has been fairly efficient at performing R&D, although the actual sums spent are not that great compared with international competitors. It is translating R&D results into products and processes that the UK has been historically very weak at and that is another area of

major concern. R&D is important but it is one element of this entire process of innovation. That is what the CBI is looking at, that is what we are trying to raise awareness of. There is more to innovation than R&D or technology. It is an entire process and perhaps the weakest link is downstream of formal R&D. To come to the second point, the accounting practice, again the focus is on R&D. That is very worthwhile because it is a thing which has been measured internationally for many years. In the US it has been a requirement to give expenditure on R&D since the 1970s. It has done companies no harm and there are signs of other benefits. This has become public knowledge. Yes, the revised accounting practices will benefit public knowledge of R&D, shareholders, analysts, research workers but I think it must be appreciated there are limitations, they are partial inputs to the process of innovation. They do not measure output or efficiencies and they are only one of the many inputs into the process of innovation. I think it would be wrong if we judged countries on their R&D expenditure. It must be useful but it is not the whole picture.

162. It is important that there should be an accurate reflection of what effort the firm is putting into research and development and important for the firm itself, important to shareholders and investors, important to Government but how important is it between one industry and another?

(*Dr Acres*) If I could answer that one for you. In our experience it is very useful to be able to compare what a company is spending compared with its competitors in a given sector and also to compare sector to sector when one is discussing in-house how much one is spending, what one is spending it on, etc., etc.. Having a definition that is acceptable to one's accountants on the one hand and maybe one's sales and production people on the other in our experience has been very valuable. It gives us that opportunity to compare what we are doing with what maybe our competitors overseas are doing off a similar base.

163. So it is important the definition should be one which is common to different industries, common to different countries?

(*Dr Acres*) For that purpose, yes. What one does with that figure and how it is broken down, whether that is by Frascati or by some modification of Frascati, that is the sort of second phase that Joe Tidd was talking about. So you have a number which is universally recognised as being a number related to R&D.

Lord Nelson of Stafford

164. What you are saying is comparative values are more important than absolute values?

(*Dr Acres*) They are at that first phase. There are various surveys being done, as some of you are well aware, within European industry by EIRMA, and in the States by IRI and similar organisations. There is a great deal of information available on how one industry compares with another, how individual companies within the individual sectors compare and where people have taken the trouble to classify R&D expenditure either into the three bands that Frascati

7 December 1989]

DR JOE TIDD, DR G J K ACRES

[Continued]

[Lord Nelson of Stafford *contd.*]

divides it into or the other bands the analysis of that figure is quite valuable because it tells you whether your effort is merely supporting your existing businesses or whether you have a significant proportion of your technical resources on developing your businesses. That is the second phase.

Chairman

165. It has been suggested to us that, in fact, firms use different figures for how they look at their research and development operations in their own internal operations and what they put in their returns to the DTI and what they actually put in their annual statement. Is that the case?

(*Dr Acres*) There are two factors in there. I think the more advanced, or thoughtful, companies will use essentially Frascati or the principle behind Frascati which is that whatever resource is being applied to add to the technology base is R&D by definition. How they divide that up may be different for internal as opposed to reporting for external purposes, but the bottom line figure will not differ significantly. The grey area comes when you consider what most people call technical support or technical services. Current thinking is that technical support is not R&D, but many companies in their annual report you will see say their R&D spend is so much and that includes technical support because of the difficulty of separating one from the other and the fact that most technical support, or a lot of technical support, is done by one's R&D groups.

166. Would the development of software be included in that?

(*Dr Acres*) The development of software, if it was software that included an innovative component, then it would be part of R&D. If it was software that you took off the shelf and merely applied to, say, improve the operation then I would call that technical support because it would not have an innovative component.

167. It would be called technical support?

(*Dr Acres*) Yes.

168. But it would not be included in development?

(*Dr Acres*) It should not be.

169. So some technical support is, some is not?

(*Dr Acres*) Right.

Lord Kearton

170. If you take a firm like IBM, they tend to mix up technical research and services very intimately. They have regarded their technical services as one of the prime reasons for their success.

(*Dr Acres*) I would agree with that. Earlier we were talking about evaluating the benefits of R&D.

171. Yes.

(*Dr Acres*) In terms of benefit, not infrequently the major benefits come from your technical support arm which is why R&D people will be involved in technical support. In that case, as with IBM, I would see the technical support phase as being an extension of the R&D phase. What Dr Tidd said was that, of course, it is part of the innovation process, therefore if one is focusing one's mind on how much resource

one is applying to innovation then Frascati gives you that number. If you want to know what resources you are applying to innovation and its exploitation, then you will inevitably have a different number. So Frascati, as the SSAP is using it, and as it is used by OECD and internationally, is a measure of, in my view, resource applied to innovation.

172. I wonder if I can take it further. I very much agree with Dr Tidd's early remarks, it is only part of a continuing process. The general argument has been in this country that you are going to have commercial success followed by profits. R&D, it is quite respectable as a percentage of GDP compared with other competitors. The evidence we have had to date says we have overstated it considerably, especially in the defence field and the defence field is a large part of the national R&D and some of it does not come under Frascati definitions at all. Is this something the CBI agrees with, in other words we do tend to overstate our national figure for R&D?

(*Dr Tidd*) We received returns from about 30 companies, it is not a definitive survey of R&D in the country. The DTI has conducted much more detailed and extensive analysis of research and technological development. Of the 30 companies that replied all of those involved in MoD related work stated that all MoD contracts are counted as R&D, but the majority of those contracts are not in the spirit of Frascati, and are essentially routine product development. Given the total Government spend on R&D is almost half on defence related work, it is easy to deduce how much this over-statement is. So it appears, yes, there is a very large overstatement.

173. If that is so do you think the country is doing enough R&D on the Frascati definitions to remain competitive?

(*Dr Tidd*) I am not aware of any studies. I do not know whether a critical mass of R&D is needed to sustain a country or a specific sector and I think that is the problem. We are not sure at what point on the continuum of innovation that the weakness lies, but because R&D is relatively easy to qualify and measure, we tend to say this is where we must do something. We can base policy decisions on R&D spend but historically problems have been downstream in the process, in product and process development, and translating results of R&D into product processes people would buy overseas. That is where the weakness lies. Unfortunately, the instruments to measure innovation in that grey area are not very well developed and we are contributing in our very modest way. Firstly, we now include a question on expenditure on innovation and we define that, as market research, R&D, and product and process development, in our Quarterly Industrial Trend Survey. That started in October for the first time. We are aware of the limitations of existing data. This is only a trends survey so we can say the trend in this sector is increasing or decreasing but we cannot say on what base and that is why we need more detailed statistics on total R&D spend.

174. If you asked the research managers or accountants, financial directors, managing directors, to whom are your queries addressed?

7 December 1989]

DR JOE TIDD, DR G J K ACRES

[Continued]

[Lord Kearton *contd.*]

(*Dr Tidd*) The quarterly industrial trends tend to go to targeted personnel, they tend to be in accounts because they have the figures. We have a second survey which was launched in September which deals specifically with innovation trends. We have two measures, if you like, the Quarterly Industrial Trends Survey which is widely reported and used, and this new survey which deals with innovation; it asks for a breakdown on the different types of spend products.

175. Who answers that question?

(*Dr Tidd*) We know that because we control that directly. They are primarily the research and technical directors for the innovation survey because it requires a detailed breakdown of spending on both inputs and outputs on innovation. Because the Quarterly Industrial Trends ask for a whole list of questions relating to stock turnover, expected sales, they tend to go to a higher person in the company who has a broader picture of the company.

176. In view of what you are trying to find out should you not ask the managing director essentially to take responsibility for the information even if he gets different departments to provide it? Is it not the philosophy behind the whole spectrum or continuum from the first idea to the finished product or service which really matters?

(*Dr Acres*) Yes. I think ideally you would but as you are probably well aware he would probably delegate the actual preparation of the document to someone like myself.

177. True, but taking Dr Tidd's point about the philosophy behind the whole R&D innovation process surely that goes squarely to the chief executive's desk?

(*Dr Tidd*) I think ideally that would be the case, but because of our experience of response rates, our first point of contact with CBI member companies is the chief executive. Again you are quite right, Dr Acres, we do many, many different surveys during the year on different subjects and inevitably the reply comes from somewhere else in the organisation. These things are delegated, but worse still when they are delegated we lose information from the organisation. Now we tend to target the person who will have most of the information, if not all of the information, to hand. I think DTI suffers, in some respects, in that to my knowledge they do not monitor well enough where the questionnaire goes, is it accounts, or research and technical directors who get the questionnaires? This may be the reason for discrepancies in, for example, contracting out R&D.

178. Has it ever been a subject at the CBI annual conference?

(*Dr Tidd*) I do not think so, although having said that, in the next year, the CBI Jubilee Year (the 25 year Silver Jubilee) we have a series of nine themes one per month, but on-going. One of those themes will be investment in innovation.

179. It is only just coming up?

(*Dr Tidd*) Yes, although we had a working group several years ago looking specifically at finance and innovation. We tend to explore things as we go along. We have limited resources. The major item this current year was infrastructure investment and I would see innovation as part of the infrastructure.

The priority was training skills and transport infrastructure.

180. Does it go up before the CBI Council?

(*Dr Tidd*) It does; it went to the last council. The nine themes were approved.

181. Despite the fact that the CBI has been in existence since 1962 or 1963, the concentration on the whole innovatory process—starting with R&D—has only just begun to surface; fair comment?

(*Dr Tidd*) I think it is fair comment. When I joined the CBI earlier in the year one of my jobs was an innovation trend survey. It has a long history. It is a case study of how to manage innovation. In the late 1970s the idea started and it is only now this year it has been launched. These things take time.

Lord Clitheroe

182. Is the compilation of R&D statistics merely a chore for industrial companies?

(*Dr Acres*) No.

183. Does it have managerial value and internal application?

(*Dr Acres*) You are probably interested to know that since it became a requirement via the SSAP13 to put R&D expenditure into annual reports in my experience the accountants have taken much more interest in what constitutes R&D. For example the definition of R&D and what benefit one is getting from that activity. There has always been some interest in that right up to the chief executive. As a result there is certainly in the companies I am aware of, and in our own, a much better appreciation of what R&D is than maybe there was previously except for the R&D director. As a result of having a bottom line figure, having a definition of R&D, separating it from technical support and being able to break it down either into Frascati categories or EIRMA categories, whichever you choose to break it down into, gives people a much better feel for what R&D is all about and how it relates to the short, medium and long term interests of the group. Hence in my experience it is not considered to be a chore. It is considered to be part of the management of the whole business entity.

184. Do you feel that really there is a common industry-specific guideline for R&D or is it an issue that all industry should be reporting the same way? Do these different definitions give you confusion or clarity?

(*Dr Tidd*) I think for the last ten years at least the major companies in Europe and America and in Japan have contributed to various surveys. EIRMA, which is close to us in Europe, did a major review of how R&D is defined, how it is best defined in industry and how the amount spent on R&D within the various industrial sectors of Europe compares against the various parameters like turnover, profit and the rest of it and within various industries in those sectors. There is a considerable consensus among those companies that carry out the major R&D as to what the R&D is and how to use the categorisation of it as a benefit within the organisation.

7 December 1989]

DR JOE TIDD, DR G J K ACRES

[Continued]

[Lord Clitheroe *contd.*]

185. Can I ask how the City reacts to this or how they are going to react to this?

(*Dr Acres*) Those of us that responded to putting R&D costs into annual reports before it became a requirement and then when it became a requirement to add a little more commentary to that one line than we might have done previously, anticipated having a positive reaction from the City. But I think most people have found that having put it in (with one or two notable exceptions that you are all probably aware of) it has not had the sort of effect we anticipated!

186. Do you read that that the analysts are incapable of analysing this problem or people are wanting money today and not tomorrow?

(*Dr Acres*) When a group from the CBI were discussing this very issue with the Department of Trade and Industry—we emphasised that a single number for R&D, although it was a useful figure to have and to be able to compare across sectors of industry, it did not tell you a lot as to what a company was actually doing with the X million that it identified. You would need to have a commentary on that and if it was an analyst they would need to have much more information before they could relate that to the short term as well as the long term performance. It might all, for instance, be in technical support in which case there would be no new business coming from the R&D effort. Alternatively, it might all be in the applied research end in which case it would be very interesting to know when that was going to be exploited. The two extremes do not happen, there is a balance. I think the analysis will come. As some of you are aware, in America there is a good deal of analysis of these very figures. Various consulting groups can relate not only how much one is spending but the balance of how one is spending it to the type of business you are or they think you are, and even to the way that they perceive that has influenced one's share price and the performance of the company.

Lord Nelson of Stafford

187. SSAP 13 does not require a differentiation between R&D?

(*Dr Acres*) No.

188. Is this a mistake?

(*Dr Acres*) I think we were discussing this earlier. If one's initial objective is to get a company basis for defining R&D in UK industry then SSAP will succeed. If you want to analyse that in terms of short term/long-term/existing business/new business, all the usual management criteria, then you get into the second phase. There are many companies at this moment that do not work on a single figure, they obviously break it down. Companies that have not arrived at the total figure required by SSAP13, who are not required to do it, underlines that once they have got this single figure—I am sure this is true—they will want to analyse it, if they are not doing it already. Hence the sort of information that say the Science Policy Research Unit or CBI or DTI might wish to take from that information will become increasingly available.

189. What you are saying is it would be a good idea to have the split, but I suppose the argument is what is the split between R&D?

(*Dr Tidd*) I do not think that is the argument really. If we are to accept it is an imperfect measure then the Frascati or accounting standards practice definition is fine as it stands, but to have any more fine detail might confuse matters. Small companies are excluded but a lot of the businesses at the moment who do not provide that information, and they are not obliged to, will be encouraged to do so. I think that the burden is great enough at this stage. If they suddenly are given this new figure at board level then they might want, for management accounting internally, to know more details, but for public and external requirements the accounting practice standards are probably fine and more than adequate, given R&D is an imperfect measure. You could argue as easily why do we stop at R&D; why do we not ask for total innovation spend and on patents and licensing? How far do you go? I think you have to accept we want an easy to understand measure for people like analysts, major shareholders, academics and researchers, who want more detail; they will follow that up. I think for public information the accounting practice is probably sufficient as it currently stands.

190. Would you say the same is true of the use of the word "experimental" in the Frascati definition in conjunction with development?

(*Dr Acres*) Yes. My own view is that the majority of people directly involved in defining what R&D spend is of a particular company would not have a problem with the word "experimental" in front of development.

191. Not even in the defence field?

(*Dr Acres*) If I take the spirit of Frascati which I think most of us in the industry accept, and I am sure the academics will also accept, then R&D is defined by a contribution to innovation and whether you put the word "experimental" in front of development or whether you do not to me is not of major importance. If one is saying to oneself does the development activity contribute an innovative component, then if it does it is R&D or it is development; if it does not it is something else. The key thing that Frascati is built on, rightly or wrongly, is innovation.

Lord Sherfield

192. Sir Robin Nicholson is reported to have said this summer that: "simple R&D statistics have their merits in that they are understood by Select Committees. However, from an industry standpoint what is important is the total spent on innovation." I think you may have answered the substance of this question already but do you agree with this statement? Would you like to comment on it further?

(*Dr Tidd*) We have covered the ground. In essence, yes, R&D figures and their values are relatively easy to interpret and they are readily available in most companies and will become increasingly so as the accounting practice spreads throughout the UK. But we have to recognise their limitations and that they represent one input into the process of innovation, not the entire range of inputs. Nor can they measure

7 December 1989]

DR JOE TIDD, DR G J K ACRES

[Continued]

[Lord Sheffield *contd.*]

output, or measure efficiency. In the world of accounts 'value for money' is the rule. Presumably the next step is to measure the other subjects on the OECD seven band scale and try to assess efficiency of R&D in translating these results into products, processes and services, that is where the value lies. We accept R&D statistics need to be collected and they are valuable with the qualification that they are of limited value when you are trying to assess how much a company, a sector or a country is innovating, producing a new product. R&D is a partial measure of input, not output or efficiency. These are more important, the output and efficiency with which limited resources are translated into new products and services.

Lord Kearton

193. Assuming at the end of the day we want a consumer suggestion because it gives us sales and profits, one element in this which in recent years has grown more important is what is called market research. I used to be the President of Market Research Society for seven years. I can give you a number of case histories depending on the quality of the market. Do you think that is a misuse of the word research?

(*Dr Acres*) That is a very interesting question. In our own case we have within our main technical centre what we call a technical intelligence unit, which is equipped with the computerised information systems where we can supposedly—well, where we can actually—access information which is appearing around the world on a minute to minute basis. That we consider as part of the R&D activity.

194. And that is a form of market research?

(*Dr Acres*) It is. We do not use the words "market research" for it.

195. One reason I am asking the question is that I was a member of the Committee which did some work on Japan earlier this year and when we talked to very large Japanese companies we found sitting right there with research were market researchers, and they were trying to find out what the customer wanted, and a lot of their new products arose directly from very detailed market research.

(*Dr Acres*) In our case the R&D expenditure that you will find in our annual report contains something like 1 or 2 per cent of the cost attributed to what we call technical intelligence. I believe that part of our success results from our R&D people having their own access to what is happening in the world.

Chairman

196. Is there not another thing rather like that, which is described as strategic research. It is certainly not basic research and is certainly not applied at the time to any specific future project, but it is building up a large area of knowledge in the field in which the firm itself does operate or even might operate. It may be done in order that the firm can take advantage of anything that comes up, or on the other hand defensively so that the firm can protect itself against other people taking it up? Would that be included? How would you include that under the Frascati definition?

(*Dr Acres*) In our case, but I am sure I speak for a significant number of major companies in Europe and the rest of the world, we use Frascati or something very similar to it and we look at the proportion of our spend on what you might call basic research or strategic research broken down into our main business units, and compare that with the shorter term research. Depending upon the strategy and policy of the group and the business units—if the strategy were for instance to develop and diversify the business and we found we were not spending any money in the new business or the strategic technology area—we would question the whole R&D spend. That is one of the big benefits of having a bottom line number which is clearly defined and taking it one stage further and breaking it down, because it enables people other than the R&D management to get an overview, the sort of thing the chief executive might want to have a look at initially, to see what sort of balance he has in his R&D spend. And hence, having the Frascati categories or a version of the Frascati categories, is very important we think in establishing whether or not you have strategic research being funded within the organisation.

197. But where do you think strategic research of that kind fits into Frascati? Is it a sub-division of basic, a sub-division of applied or is it wandering about between the two?

(*Dr Tidd*) May I return to the survey we carried out earlier in the year. We asked members what their view was on the introduction of an additional category of 'strategic research' and overwhelmingly people said no, there are enough categories as there are, and it is far from an exact science putting spend in existing categories. What many said was that the existing Frascati criterion for basic research was unrealistic in most industrial contexts. For example, the EIRMA working party back in 1983 or 1984 did a survey of their membership and they estimated less than 7 per cent of total R&D spend would satisfy the criteria for basic research. So what CBI members were suggesting was, if we need to introduce strategic as a category, we should use it in place of basic research, and just have a strategic research category. Having said that, they qualified it by saying, that of course this would not apply in the case of scientific research carried out in universities and other public institutions where they would have a very different understanding of strategic and basic research. So perhaps we get into a complex area where we have different definitions in industry from those we use in academia. But industry does not think we should have separate categories of basic and strategic because it is very difficult to have more and more compartments and you introduce spurious accuracy if you ask for smaller and smaller categories within that total R&D spend. The requirement under Frascati for basic is "without any particular application or use in view", and the majority of members we surveyed said they did not do that sort of thing. There is always some application in view, no matter what the time horizon.

198. But the Government splits this up into applied strategic and applied specific. Would that not suit you? What you have just described, the sort of strategic which industry does, you like to see counted

7 December 1989]

DR JOE TIDD, DR G J K ACRES

[Continued

[Chairman *contd.*]

as basic but would be in the Government's applied strategic.

(*Dr Acres*) This is where you get into the second phase of R&D definition. I think you need as simple a definition of R&D as you can get, which people can understand, to give you a bottom line number. But then you have to break that number down and how you break it down depends upon what you are looking for. So for instance if in a particular company or sector or within the Government spend on R&D you wanted to have a look to see what proportion of your basic research was strategic, I would anticipate from the way we use these numbers that is a relatively simple thing to do. In my experience you want as easily understood definition of R&D as you can get, because otherwise it gets very diffuse.

199. We get conflicting demands here. You get the demand to make it as simple as possible, and then at the same time people are saying, "In order to fill it in properly, I want examples." You then begin to have examples of different kinds, and then you begin subdividing it.

(*Dr Acres*) I think what people are doing, with due respect, is that they are trying to answer several questions out of one base. Our experience is that first and foremost the question is, how much do you spend on R&D, and once you have that number you can then say, what proportion do you spend on strategic research or development, however you want to cut the cake. That is the second question. Is it experimental development or is it product development.

200. Two things, it seems to me, come out of that. It seems to me from your argument you are in fact arguing for a definition of strategic. To take the overall, industry and academia, there is not much argument about what is really basic research and that industry takes very little part in it. There is then, as I see it, an area of strategic research which means different things at the moment between industry and academia, and then there is development. However, from what you said earlier on, if you are going to use these figures as a management tool or for people to analyse their industry and see how well it is going, then you need to have further sub-divisions on development, to look at it very carefully, which would perhaps involve your technical services. Now, am I right in what I have said or not?

(*Dr Acres*) You are right. Where we as a company use it, and I do not want to impersonalise it too much, but we in fact use the EIRMA categorisation which breaks it into 5 areas. Basic research is the very long range work that we do. That is only targeted in the sense that it relates to our core businesses and that can be pretty wide. Then we have research that is targeted at a major new product or process, with the emphasis on new. That is the second category. The third one is work that is targeted at major improvements to our existing products and processes. The fourth one is development and that is relatively short term and that will result in minor improvements to our existing products and processes and the fifth one is technological support. That is how we break it down and that, or something very similar to it, is how a lot of European companies and

American companies break it down. In other words it is slightly different to Frascati in that it is product and business related rather than technology related but the bottom line comes to the same thing as long as you exclude technological support.

Lord Nelson of Stafford

201. Supposing the Government, as they sometimes have, considered introducing tax incentives for R&D. Have the CBI given any thought to whether these definitions would be sufficient under those circumstances, bearing in mind what is happening in a number of other countries?

(*Dr Tidd*) I think generally the CBI does not support the idea of having tax incentives for R&D.

202. It does not?

(*Dr Tidd*) It does not. It would prefer to see blanket reductions in taxation or in interest rates because it feels specifically targeting tax incentives on, say, R&D could distort investment decisions at firm level and it feels these decisions should be left to the firm. In addition if we look to where tax incentives have been available for sometime, as in Canada and the US, academic research is inconclusive, e.g. research done by Mansfield in the US, suggests R&D spend has increased by one or two per cent at the most since it has been in force but that is more than offset by the loss of revenue to the government and the proportion of that which would be put into government R&D. So the entire cake has not increased, it is just in different areas. So I think the evidence is inconclusive and the CBI's view on that is they would prefer a blanket reduction in tax and interest rates so profits can be ploughed back into R&D or research rather than targeting R&D as being more important than other factors.

203. That is the CBI's view on that principle but supposing the government did decide that that is what they were going to do, would these definitions stand up adequately as the basis of any such tax concessions?

(*Dr Tidd*) It depends what the objective of such a policy was. If it was to encourage R&D it would need to recognise Frascati as the internationally accepted definition. As far as the performance of British industry is concerned targeting R&D would be wrong because arguably that is not the major area of UK weakness. So I think it depends what your stated objectives are. The US evidence suggests that the effect of tax incentives may not be significant, but if your objectives are to increase the competitiveness of British industry I think there is almost no question that that would not be a very efficient approach.

Lord Erroll of Hale

204. To go back to Dr Acres and the SSAP13 and your categories, are those compatible with Frascati or would you have to revise your categories to fit in with SSAP13?

(*Dr Acres*) Four of those categories relate directly to Frascati. We include technological support in our analysis of our total R&D spend because we, like the other members of EIRMA and also various bodies in America, believe that it is important to have that figure alongside your R&D spend because your R&D

7 December 1989]

DR JOE TIDD, DR G J K ACRES

[Continued]

[Lord Erroll of Hale *contd.*]

resources are to a large extent used for technological support. So the EIRMA categorisation and Frascati give you the same total spend for R&D if you exclude technological support.

Chairman

205. It has been suggested to us the whole question of R&D carried out on contract gets either distorted or missed out or counted double. Could you comment on that?

(*Dr Tidd*) I think we come back to the question of how you collect R&D statistics and the practical problems you have with questionnaire based surveys. You do not know who it goes to, or how many people, and you have very little control that it goes to the same type of person in all organisations. For example the DTI survey asks for the sources and uses of R&D broken down into various categories so in theory we should have no double reporting of contracted R&D but it happens, so this suggests the person replying to the questionnaire does not have the information to hand on both the sources and uses of R&D within that unit. So I think we have an inherent problem there and I think that is reflected in the overall belief of our members that the R&D statistics are probably no better than plus or minus 10 per cent nationally. Very few companies have one person who can complete the questionnaire and have all the information on sources and uses of R&D expenditure within the company. I think this is a difficult problem to solve. I know EIRMA have a guide, a formula that tries to eliminate this sort of thing by trying to define the R&D function; you define certain things, contracted in, contracted out, and that is very helpful but it still assumes that the person has all the information to hand so I think it is an inherent weakness of the system of questionnaire based collection of statistics.

206. Is EIRMA different from SSAP or different from a DTI survey?

(*Dr Acres*) It is more detailed and it is more specific. I do not believe, if I recall the SSAP document, that it addresses itself to who in the collection of R&D expenditure has responsibility for contracted R&D. EIRMA, in their recommendations, suggest that the body responsible for paying for the work should include it in their R&D costs. If you are carrying out R&D that somebody is paying you for, you subtract that from your R&D expenditure and that is the principle upon which we as a company operate within. We do not get double accounting within our own numbers.

207. EIRMA is just advice is it?

(*Dr Acres*) Oh yes. EIRMA, just for the record, is the European Industrial Research Management Association. Probably about 175 European companies at research director level are members of it. It is essentially a body that is concerned with research management. Working parties produce working group reports and within it there will be advisory recommendations, no more than that.

208. And do people adopt their recommendation?

(*Dr Acres*) Yes.

(*Dr Tidd*) I think they do.

(*Dr Acres*) To a considerable extent.

Lord Kearton

209. How do you at Johnson Matthey treat your work on catalytic converters, of course a lot of which has been known for donkey's years?

(*Dr Acres*) Initially it was really a question of bringing engineering technology and catalytic technology together in order to get it to work on a car. That we would have classified as new business R&D initially. Then, once we had satisfied British Leyland, as it was, —

210. That you had got from 10,000 hours to 25,000 hours?

(*Dr Acres*) That is right. — then it would have been handed over as a product and would have required a certain amount of technical support. The initial catalysts were oxidation catalysts, and then the demand came in for three-way catalysts. At this stage research came in again, even strategic research.

211. What is clear is that even for a relatively straightforward project, which can be described simply, it is very complex when you analyse the spend?

(*Dr Acres*) I think, with due respect, a lot of people believe that to be the case. Our experience is that when you have broken down your R&D into the categories you are going to use, either Frascati if you want to look at it from one direction or the EIRMA categories from another, our experience is that people find it much easier to explain whether you are doing development work, technical support or strategic research. For instance and not surprisingly, I think we could say we are doing strategic research into looking for ultra clean power systems for vehicles, because, for a variety of reasons, as some of you will be aware, there is a possibility in America that they will ban the internal combustion engine.

212. Maybe using different precision models?

(*Dr Acres*) Yes.

Chairman

213. Is overhead expenditure included in total R&D, or does it disappear somewhere else?

(*Dr Acres*) It depends. Where you have a technical centre which is virtually a stand-alone unit, that provides all its own services right down to the gardeners, then the cost of running that centre and the cost of the project man in it includes all the overheads. In my experience the difficulty arises when you have a development group attached to a product/sales/marketing centre. Then what tends to happen is that they get their services ostensibly for free. Hence you get this discrepancy between a man in development costing £25,000 a year and a man in your research centre costing £75,000. The answer to that is that they are getting their services free. But increasingly in my experience, now that there is a requirement to define R&D and the accountants are that much more concerned about it, they start to ask questions as to why this man costs £25,000 and that one £75,000. Then they say, "We are not costing R&D properly in this development group, let us have the proper cost." But it could result in an underestimate of the UK's R&D expenditure because of some of our qualitative accounting.

7 December 1989]

DR JOE TIDD, DR G J K ACRES

[Continued]

[Chairman *contd.*]

214. Could not an under-estimate also arise from the exclusion of small firms from the DTI survey?

(*Dr Tidd*) I do not think that is a big problem. If we are measuring R&D, and we have probably accepted that is all we can hope to do using the method of standard accounting practice in the DTI survey, and if that is our aim, just restricting it to firms with more than 200 employees is a wise thing to do. Academic research worldwide has confirmed that formal R&D is carried out in large companies: very large companies, having typically more than 5,000 employees, will account for 70 to 90 per cent of all formal R&D in a specific country. So that is not going to introduce any serious errors in the expenditure on formal R&D, and that is what we are trying to measure. Going back to innovation, if you look at emerging research on the role of small companies in Japan and the role of small companies in product and process development, the more general areas of innovation, it is much more significant. So if we begin to measure that, we have to start bringing back small companies and how they look at that and how they contribute to it. If we are aiming just to measure R&D proper, it is not an error missing out the small companies.

Lord Nelson of Stafford

215. To what extent do you think research and development into new manufacturing methods appears in the statistics? There has been no mention of that, and we are talking about development of products all the time. The most important element is new manufacturing technology. To what extent is that left out, do you think?

(*Dr Acres*) People are using Frascati and if that involves innovation, which it is almost certain to if it is really new manufacturing methods, it would be in the R&D equation and in the spend.

216. Do you think it would appear in the company's figures?

(*Dr Acres*) Yes.

[*Lord Nelson of Stafford*] A lot of innovation in manufacturing is not done in the traditional research departments or product development departments, it is done in the planning departments and the manufacturing departments themselves.

[*Lord Erroll of Hale*] The foreman's office!

Lord Nelson of Stafford

217. It does not appear in their figures at all as R&D.

(*Dr Acres*) That is why it is so important to define what you mean by R&D. To give a specific example in the metals industry, if one is going to move to rapid solidification as a one-step process in producing steel, you are not likely to be able to change your established plant to that type of technology overnight, and that is going to require a significant development effort. I would be surprised if British Steel and the like did not have the R&D group involved, even if the R&D group was part of the development activities and the production unit. Now certainly in those companies which are responding to SSAP13—and everybody ought to be—now that

people are that much more aware of what they should be including, they will pick that up.

218. But they are only just beginning to pick that up, maybe?

(*Dr Acres*) Yes, you certainly have a point. Traditionally R&D is seen to be work in test tubes and small crucibles, particularly in the UK. Resources that go into developing the product may not in the past have been picked up under R&D. More likely they would have been absorbed into production costs. But now people are focusing more on what they are spending on R&D, where it is being spent and chasing the numbers through to the shop floor. Hence they will pick up the total cost of R&D.

Chairman

219. Does your contact with the multinationals lead you to any conclusion about whether this collection of statistics produces better results than in European companies, or worse? Do you have any knowledge?

(*Dr Acres*) Certainly the bigger companies with a substantial R&D spend will be working to international standards. We all read the same R&D management text books, we all read EIRMA and IRI and the Japanese MITI reports, and we all think it is a good thing to know what we are spending on R&D, so I think you would find that those companies, particularly the bigger ones with R&D groups, will all be working to very similar criteria.

220. But you have no comment on the collection of statistics by European companies?

(*Dr Acres*) In terms of collection of statistics and analysis of the numbers, there are significant differences, but of course you have to start somewhere. In America there is 15 years, at least, of R&D statistics which you can look at, as there are in some European countries. There are also OECD statistics one can examine. Hence the sooner one starts the better even with an individual company.

Chairman

221. But looking at the OECD statistics as they are today, I mean do you think they do provide a good comparison between different countries?

(*Dr Acres*) I think they are a qualitative guide. From what is emerging now as a result of people being that much more concerned about R&D and what is included in the costs, one can start to see that, say, the numbers that appear for Japan may not be quite the same as America, Germany or the UK. But the fact that there are numbers means that you can go to Japan and examine them and begin to get an understanding as to whether and how they relate to the UK.

(*Dr Tidd*) The OECD statistics are the major source, but in relation to any problems you might have of consistency across national boundaries I think the major value is establishing historical trends in different countries. These sort of things are valuable even if the cross country comparisons may not be clear at any one point in time. So perhaps the snap shot is less valuable than longitudinal studies where you can carry out a study of historical trends and I think that is very valuable indeed.

7 December 1989]

DR JOE TIDD, DR G J K ACRES

[Continued

[Chairman *contd.*]

222. So the conclusion do you think to be drawn from that is do not change the system too often?

(*Dr Acres*) Yes.

Lord Kearton

223. I think after hearing the very interesting discussion, Dr Tidd's first estimation of plus or minus 10 per cent might be a bit on the optimistic side?

(*Dr Tidd*) That was a consensus among the 30 member companies that responded. The widest one, to give you an idea of the standard deviation of that, was plus or minus 100 per cent, but most people opted for plus or minus 10 per cent, perhaps to retain some sort of rationality in the interpretation of data.

224. A lot of basic research is done in universities and there is an increasing amount of industrial work contracted out to universities and they have been accused of not recovering 10 or 20 per cent of their

overheads and it might be as high as 40 per cent or 70 per cent and this is going to have quite an effect, it seems to me, in two or three years time on the returns we get in these particular areas. We are not going to be spending more in real terms.

(*Dr Acres*) And the same applies to the cost of research in different countries as a result of exchange rate variations and the cost of labour. For example, when you are looking at the proportion of R&D finance that the Japanese government provide to Japanese industry compared to ours you need to take into account these factors in explaining some significant differences.

Chairman] The present number is much smaller. Thank you very much Dr Acres, that has been most helpful. I am not sure I am much clearer in my mind what I will recommend but it covered the ground very fully and I am most grateful to you. Thank you very much.

THURSDAY 8 FEBRUARY 1990

Present:

Carver, L. (Chairman)
Chorley, L.
Erroll of Hale, L.
Flowers, L.
Gregson, L.

Kearton, L.
Nelson of Stafford, L.
Shackleton, L.
Sherfield, L.

Memorandum by the Ministry of Defence

RESPONSE TO QUESTIONS PUT BY THE SELECT COMMITTEE

Q1 Do you use the Frascati definitions in making returns to the Annual Review of Government Funded R&D? If not what definitions do you use?

A1 MOD figures of R&D are broadly in line with the Frascati definitions. We do this however by reporting on the blocks of expenditure from our accounting systems which correspond as closely as possible to the Frascati definitions. Since these systems were created primarily with the needs of financial accounting and accountability in mind questions of classification arise in certain areas. The extent of these is currently being studied.

Q2 Do you use the same definitions in your day-to-day operations, or is it necessary to use other definitions? If so how do these definitions differ from those used in the Annual Review?

A2 We use the same definitions for the Annual Review, in the main, as are employed for the Statement on the Defence Estimates. The figures either reflect precisely those in the published Estimates or are derived from them in a straightforward way.

Q3 Do you experience any difficulty in converting your figures for R&D spending into the format required for the Annual Review? Do you encounter any other problems in making returns to the Annual Review?

A3 There are only minor adjustments required to convert the figures in the Statement on the Defence Estimates into the required format — eg in the area of superannuation costs.

Q4 What explanatory notes or guidelines do you use in interpreting the Frascati definitions? Are they adequate for this purpose?

A4 There are established routines for the collection and analysis of R&D data within MOD. Interpretation of the Frascati guidelines, when required, is by direct reference to the OECD manual. Some difficulties can be encountered because the manual does not deal with defence-specific items or with more modern technologies including computer software.

Q5 It has been suggested to the Sub-Committee that many of the tasks involved in major MOD development contracts do not contain the 'appreciable element of novelty' which is at the heart of the Frascati philosophy. What is your understanding of an 'appreciable element of novelty'?

A5 This is an area we are currently looking at. MOD's printed Estimates, on which the Annual Review data are based, assume that 'development' continues to the point where 'production' begins, since this corresponds to the usual contractual arrangements. Clearly the degree of novelty in such work varies. There are however difficulties in seeking to discriminate between different tasks where they are bound up in a single contract.

Q6 What degree of subjectivity is involved in categorising your R&D spending? Is it possible to attach confidence limits to your figures for R&D spending?

A6 Because of the methodology described above, the subjective element is at present low.

Q7 Do the Frascati definitions provide a clear means of differentiating between:

- (a) basic and applied research*
- (b) research and development*
- (c) R&D and other related activities;*

for the purpose, in each case, of:

- (i) compiling statistics of the MOD's intramural R&D expenditure;*
- (ii) compiling statistics of the MOD's extramural expenditure;*
- (iii) compiling R&D statistics within a scientific and/or industrial sector;*
- (iv) comparing R&D activity between the civil and defence sectors;*
- (v) making international comparisons of R&D activity?*

8 February 1990]

[Continued

A7 Answers are as follows:

(a) This does not apply as no 'basic' research is carried out as part of the Defence Programme.

(b) (i), (ii), (iii) and (c) (i), (ii), (iii)

The Frascati definitions provide a clear theoretical means of differentiating between these categories. Questions of classification arise in fitting available information to the definitions rather than from any lack of clarity of the definitions themselves. (See A1)

(b) and (c) (iv)

MOD is not aware of any problems caused by lack of clarity of the definitions in comparing civil and defence sectors.

(b) and (c) (v)

The Frascati definitions provide a clear theoretical means of comparison. It is more difficult to be certain whether the definitions are applied consistently in different countries.

Q8 Are there any specific inadequacies of the Frascati definitions and how might they be amended? For example the US Department of Defense sub-divides experimental development into 'exploratory', 'advanced' and 'engineering' development. Would there be any advantages in the use of these or other categories to classify your own development expenditure?

A8 The framework provided by the Frascati definitions is adequate for current MOD needs and there is at present no perceived need for an alternative sub-division. There would be no advantage from MOD's point of view in classifying development expenditure into sub-divisions, along the lines, for example, adopted by the US Department of Defense. MOD's main concern is that expenditure on development is managed in a way which reduces and controls financial and technical risk. In order to achieve this objective, funding for each development project is committed in stages (Feasibility Study, Project Definition, Full Development). Funds are committed to the later stages only when the earlier stage has provided sufficient confidence in the technical soundness of the proposal. These stages are determined in each case on technical grounds and do not necessarily coincide with any particular statistical definition.

Q9 Would you give specific examples of the work funded under each of the headings in Table 1.22 of the 1988 Annual Review, ie

(a) applied-strategic research.

(b) applied-specific research.

(c) experimental development.

A9 Examples are given at Annex.

Q10 Did any of the work funded by you in 1986/87 fall outside the Frascati definition of R & D, but within the range of related activities which you have difficulty in distinguishing from R & D? If so would you provide specific examples of those activities with which you had difficulty. Was this spending included in Table 1.22? If not where was it reported?

A10 Table 1.22 deals comprehensively with MOD spending on R&D. One marginal area excluded from the figures is operational analysis carried out at the Defence Operational Analysis Establishment (DOAE). This has affinities with some of the analytical work carried out in the defence research establishments, which is included in the R&D figures in view of its more technological orientation. DOAE costs are accounted for under MOD Vote 1.

Q11 The Annual Review of Government Funded R&D also classifies R&D spending according to 'primary purpose'. How does this classification differ from Frascati? What advantages if any does this classification have over Frascati?

A11 The classification of R&D spending according to primary purpose is merely a sub-division of the Frascati classification and therefore conforms to the same overall framework. It provides more detail about the intended end-use of the R&D expenditure.

Q12 In the Annual Review of Government Funded R&D there is an 'apparent discrepancy' between the amount that government says it spends on R&D in industry and what industry says it receives from government. How does this situation arise and how can it be improved?

A12 The Government's understanding of the reasons for this discrepancy is explained in para 2 of section 1.2 of the Annual Review of Government Funded R&D 1988.

Q13 It has been suggested that the number of scientifically and technically qualified personnel employed in R&D is a better indicator of R&D effort than is the figure for R&D spending. Do you agree?

A13 It depends on the purpose of the analysis. If the emphasis is on the availability of manpower resources then clearly the number of scientifically and technically qualified staff is a major factor. Personnel figures also focus attention on what at the higher levels of R&D may well be the factor in shortest supply. There are however other factors involved in R&D which such figures ignore such as facilities and equipment

*8 February 1990]**[Continued]*

which would be picked up in a statement of cost. It may also be difficult to trace accurately the number of qualified personnel involved where work is contracted and sub-contracted out.

EXAMPLES OF WORK FUNDED

(a) Applied strategic research

(i) Shock Transmission Mechanisms

This research investigates the transmission of underwater shock through various materials in order to establish material/structural arrangements which would significantly reduce the vulnerability of ships and submarines and their equipment to underwater explosion attack.

(ii) Speech Signal Processing

The objective is to develop improved low-level representation of speech signals for higher accuracy automatic speech recognition (particularly in difficult environments) and higher quality speech synthesis; to investigate techniques for separating speech from competing signals; and to exploit non-acoustic speech-related signals as a supplementary source of information in extremely noisy acoustic conditions.

(iii) The Influence of Very High Performance Integrated Circuits (VHPIC) on Future Avionic Systems Architecture

The aim is to derive and assess avionic system architectures which effectively utilise the benefits of VHPIC technology, particularly greatly increased processing power and complexity of functions, whilst meeting the constraints inherent to its application.

(b) Applied specific research

(i) Theoretical Propellant Studies

This research is aimed at increasing the performance and reducing the vulnerability of direct and indirect fire weapons and missile systems by developing modelling techniques to predict thermodynamic properties and in-Service life of gun and rocket propellants.

(ii) Structural Materials (Crack Propagation)

The objective is to provide information on corrosion fatigue, stress corrosion and fatigue crack propagation in steels for current and future use in submarine hull construction.

(iii) Aircraft Acoustics

The multiple objectives are: to quantify the effects of noise and other stresses on crew performance; improve acoustics aspects of aircrew equipment; obtain in-flight data on cockpit noise; identify and provide solutions to acoustic problems likely to affect aircrew in future aircraft; and specify acceptable noise levels.

(c) Experimental Development

This embraces the full range of development work on equipment projects for the Services. During 1986-87, the outturn year in the 1988 Review, projects funded included the following:

- Vertically Launched Seawolf
- EH101
- Sonar 2054
- Multiple Launch Rocket System (MLRS III)
- Rapier (Field Standard C)
- European Fighter Aircraft
- Harrier GR 5

8 February 1990]

[Continued]

Examination of Witnesses

MR W F MUMFORD, CB, Assistant Under Secretary of State R&D Establishments and Research Administration—AUS(ER), MR N H NICHOLLS, CBE, Assistant Under Secretary of State (Systems)—AUS(Systems), MR D E HUMPHRIES, Assistant Chief Scientific Adviser (Projects and Research)—ACSA(PR), MR E J LOMAS, Head of General and Financial Statistics Division, and MR P A CROWTHER, Head of R&D Establishments and Research Administration 1, Ministry of Defence, called in and examined.

Chairman

225. I would like to thank you and your team very much for coming along today to give evidence on this subject, and thank you for succinct answers to our questionnaire. I think you can see who we all are; we have our names in front of us. It might be useful both to the members of the Sub-Committee, because we have not met on this subject for some time now, and perhaps to you if I said why we are doing this study, and what we are really after and some of the broad conclusions we have already reached. It arose because previous studies of the committee, particularly on civil R&D, were dissatisfied about the figures produced showing research and development effort both in industry and by Government, when the research and development figures were supposed to be indicators of innovation. It was felt that they in fact—either in industry, in many cases, or as far as Government financed research was concerned—were not a true indicator of that. We got a whole lot of figures from industry from which it was clear that there were differences in the way, in various different industries, they defined their research and development, and also what they said their effort was under certain definitions. We looked at the definitions themselves and said, “Ought they to be changed? Is there something wrong with the definitions?” After a considerable amount of examination and discussion we have really come pretty well back to the idea that there is nothing better than the Frascati definitions as included in the book, although there is still a good deal of disagreement about whether there should be a definition of strategic research which, as far as Frascati is concerned, is included in applied. We looked at the way people said what they were doing under the various definitions and, hitherto, all the evidence that we have received points to the distortion produced by the Ministry of Defence figure for development. It is by far the largest single figure in the whole issue of civil and defence R&D put together, and including it in Government expenditure on research and development makes it look, in the opinion of the Committee, as if the United Kingdom is devoting much more effort to innovative R&D than, in fact, it is. This is because, as your own answer makes clear and I know from my own personal knowledge, the Ministry of Defence includes everything that goes on before the placing of the production contract under the term “development”; whereas all the evidence we have received, and you yourself in some of your replies, indicates that there is quite a lot of expenditure in that which could not be classified under the Frascati definition of experimental development as being innovative. It has been suggested to us particularly by Ivan Yates, whether speaking on behalf of British

Aerospace or SBAC, that he believes it possible in the Ministry of Defence to break the development figure down into something which shows what is really innovative and what is not. I think that is really the key to what we are after. Does the Ministry of Defence admit that a significant element of what it classifies now in its return to the Annual Review of R&D and elsewhere as development is not really Frascati-defined experimental development and, if so, in order that there should be true comparisons between defence and civil and between this country and other countries, is it possible some time to present a more accurate figure? It would seem to me personally to be in the interest of the Ministry of Defence to do so to avoid the accusation, which is constantly made, that too much money goes into defence R&D and not into civil. That is an introduction to what is behind our inquiry. Do now introduce your team and make any statement in amplification you would like.

(*Mr Mumford*) Thank you very much, my Lord Chairman. On my right I have Mr Nicholls, Assistant Under Secretary of State (Systems); and on his right Mr Crowther, Head of R&D Establishments and Research Administration 1; on my left I have Mr Humphries, Assistant Chief Scientific Adviser (Projects and Research); and on his left Mr Lomas, Head of General and Financial Statistics Division who is in fact responsible for putting all our figures together. Thank you very much for that introduction. I would like to say in the first place that we do use Frascati definitions in presenting our R&D figures. That is stated in various publications. I can confirm that we do use them. Our R&D figures are produced by reporting on blocks of expenditure from our accounting systems which correspond most closely to the Frascati definitions. Those accounting systems, as I am sure you are aware, my Lord Chairman, were created primarily with the needs of financial accounting control and accountability in mind. Questions of classification do arise in certain areas when we seek to extract from our blocks of expenditure figures which correspond to the Frascati definitions. We are at present studying whether further refinement in our process of extraction and attribution could be done. These are quite complex studies and, of course, they do not only involve looking at the work of our research establishments, intramural research, but also would require us (and this is something we would have to discuss with industry) to obtain a good deal more information from industry than we seek to extract at the moment from our contractual procedures, in order to pursue a process of refinement in attribution to Frascati. I think our studies are in a fairly early stage at this moment and they certainly have not gone far enough for us to draw any valid conclusions from them. We

8 February 1990]

MR W F MUMFORD, MR N H NICHOLLS,
MR D E HUMPHRIES, MR E J LOMAS AND MR P A CROWTHER

[Continued]

[Chairman *contd.*]

have not yet embarked significantly—although we are in touch with industry on a whole range of things and are aware of the Ivan Yates study for example—on any studies in depth with industry on this particular problem.

226. Do you admit that a significant element of what you classify as development and show in the Annual Review of R&D as development, is not development within the Frascati definitions of experimental development?

(*Mr Mumford*) On the basis of our studies so far we would not admit that. We do not feel we have a sufficient statistical basis to make such a statement.

227. Why does everybody else say that is the case?

(*Mr Mumford*) I am not sure everybody else does say it, quite honestly, but we are aware of the British Aerospace study. Of course there are some factors which have to be taken into account in considering and examining the views taken by industry on this matter. The latest Cabinet Office Annual Review of Government funded R&D did set out a number of reasons why industry could be itself under-estimating the Frascati element and indeed R&D expenditure as a whole. For example, the industry figures obtained by the DTI exclude enterprises with fewer than 200 employees, whereas Government estimates include such enterprises, and there could be quite a lot of those. Sub-contractors of prime contractors in industry are not always in a position to recognise the Government as the ultimate source of funds. Sub-contractors may not appreciate their work is an essential element of a major contractor's R&D programme and may not therefore classify the expenses they are getting under sub-contracts as R&D. Our R&D figures include the profit element whereas with industry estimates we understand they explicitly exclude profit. This is a difficult statistical area. There are a number of quite important factors which could lead industry in assessments such as were made by British Aerospace to quite substantially under-estimate on their side.

Lord Nelson of Stafford

228. To clarify your point, my Lord Chairman, could I just ask one specific question? One of the major items under your development expenditure must, I am sure, be flight trials. It is a very expensive game. Where do you put that? That presumably is in this R&D figure but there is very little innovation in flying aeroplanes around for hours and hours in order to prove the engine is reliable or something else or it will perform up to the altitude required?

(*Mr Mumford*) I am not sure where that is. A good deal of flight trials are conducted by industry and would not necessarily be included. But I will ask Mr Lomas to answer that.

(*Mr Lomas*) Where a flight trial is undertaken on behalf of a defence contractor as part of the pre-production process, no we would not include that. Where it was definitely part of the development activity, where there was no commitment to production, we would.

229. Take a piece of electronic equipment which has to be flown around for long periods of time, in the development phase of the electronic equipment does

all that flight expenditure go down as development expenditure?

(*Mr Lomas*) If it is part of a development contract with no commitment to production at that stage, yes it would be. The difficulty is that we count a lot of supporting activities, which it is necessary to carry out, as development in our expenditure of R&D. That may not be the case with industry. I have no idea how they put their figures together.

230. This is the sort of area where people think the figures are getting distorted, because such a large part of the expenditure is not innovative at all in fact.

(*Mr Lomas*) To quote Frascati, we have to include such things as security, storage use, repair and maintenance of buildings and equipment. They should be included in Frascati R&D expenditure. That clearly is not innovative but it is in support of an innovative activity.

(*Mr Humphries*) When you are talking about testing, during the development phase it is undoubtedly often actually pressing the state of the art to make the thing which is being developed actually work. Very often development test capabilities, engine tests for example, are innovative in their own right. So there is a secondary spin-off from this work which you could not discount totally. With the work you describe as being not innovative, there are elements of it which are innovative, particularly when as so often happens our equipments are pushing the state of the art.

Lord Flowers

231. We are talking very largely about words, about definitions, categories and so on. What is causing us distress is that you appear to use these words in different ways from other people, and then when comparisons are made with other countries, for example, things look funny. How much effort do you put into discussing what those categories mean in terms of how other people in the civil sector in this country, or in civil or military sectors abroad, interpret them? Because even if you were obeying, so to speak, what they appear to say to you, if other people interpret them differently, it is in a way not helpful for you to bend the rules to fit what other people do.

(*Mr Mumford*) Certainly we keep in very close contact with the rest of Whitehall on this matter. The Annual Review of R&D is co-ordinated very systematically by the Cabinet Office. Mr Lomas can expand on the kind of contacts we have with them but they are very close. We in the Ministry of Defence have our own contacts with the other departments who contribute to Government R&D figures. As regards the international scene, we have discussed this issue with our allies, and indeed I personally took the initiative about 18 months ago to set up a workshop in NATO, the Economic Division of NATO, which was attended by all the major NATO countries, not just to discuss Frascati but to discuss the importance of defence R&D in national defence projects. In regard to your question, my Lord, I think it was quite significant that most countries who took part in that discussion, which was an informal one, admitted that they all face problems of classification, particularly in the dividing line between development

8 February 1990]

MR W F MUMFORD, MR N H NICHOLLS,
MR D E HUMPHRIES, MR E J LOMAS AND MR P A CROWTHER

[Continued]

[Lord Flowers *contd.*]

and production. The Americans said they come up against this problem, and the Germans and Dutch and so on. We feel this is not a problem which is unique to the Ministry of Defence. Having said that, I think the general feeling in the group and in other discussions we have with our allies, is that probably Frascati is the best we have got. It is what the OECD use and we do our best to comply with Frascati and present a genuine picture.

232. This takes me on to my second and related question. We have been talking about the development-production border line, one can also talk about the applied-basic border line. You claim, quite correctly I imagine, by the strict interpretation of the rules that the Ministry of Defence does no basic research at all?

(Mr Mumford) Yes.

233. But you do do research which is directed towards increasing knowledge and understanding in certain fields which are related to long-term national security needs, and that by strict definition is applied work because it is directed towards certain needs. All I can say is that the actual work you do under that heading, things like material science, use of lasers in investigative areas, properties, materials techniques and so on, are things which many industrial firms and many other government departments I think would call basic research, even though in the long-term they are directed to some purpose. I just wondered whether there again there is a difference of interpretation in what the words mean, whether you may actually be strictly more correct than the others but whereas, as a result, we get false comparisons?

(Mr Humphries) We certainly apply that strictly, that particular definition. In our role as spenders of defence money on research we really must see that there is an ultimate defence application to the product of any research that we sponsor. In fact it is one of the key criteria, when we vet the proposals which come to us from the research establishments for the most innovative and far-looking research, that it does fit into exactly that category; that there is an application for it if it pays off in the defence world.

234. However long-term?

(Mr Humphries) We do set a target of around 10-15 years pay off. We do not go any further forward than that. We do, I think, also make sure that, in fact, it is directed in this way. There is, of course, a spin-off from it. It does produce information which, if it was found in another way, perhaps would have been classified as basic research. We are doing it because we can see an ultimate defence application. Under those circumstances we believe that it is the applied research definition which applies.

Lord Flowers: I think you are correct and everyone else is wrong, but that makes the comparisons false.

Chairman

235. You will not get the money if it is said to be basic.

(Mr Humphries) We would have some very severe questions asked by my colleague on the right about spending money on things that did not have a definite defence application.

Lord Gregson

236. You must be aware of the discrepancy between yourselves and industry in apportioning the percentage of your spend to R&D, and the Frascati definition is very wide indeed and it cannot be bridged by the sort of points you are making relating to the expenditure. With both the CBI and British Aerospace—if you take the various comments they have made in giving evidence—we are talking about figures like 20 per cent. to 50 per cent. of the expenditure that they spend on your behalf which they feel could be classified as Frascati. It is not true to say you are not aware of the basis on which industry allocates its expenditure, because I know very well that you have looked very carefully at SSAP13 and that is the basis on which industry allocates its expenditure in order not to be qualified by accountants in their annual reports. That information is well documented and has long been available. Considering, in effect, that two-thirds of the money you show in your expenditure accounts is actually spent by industry, there really is an enormous discrepancy between what you are saying and what industry has told us. If I could also turn to the other question of what is spent by the establishment. You may well be aware that I did spend a few years trying to negotiate the purchase of one of your establishments under the Strathcona recommendation. I had to make an assessment of the various activities of that establishment. I must admit that if I had to allocate the various expenditures relative to Frascati it would certainly be at the bottom of industries' assessment towards the 20 per cent., if not less, rather than towards the 50 per cent. There really is a very enormous difference between what industry thinks you should allocate and what you are telling us could be allocated under Frascati. That makes it very, very difficult to accept the sort of definitions you are providing us with.

(Mr Mumford) I do not think I have a great deal to add to what I have already said. We are certainly conscious of the claims made by certain sectors of industry.

237. It is not just the SBAC, it is the CBI as well.

(Mr Mumford) I am not sure whether the CBI have told us directly about the results of their studies.

Lord Gregson] That is their problem and not ours.

Chairman

238. I can quote them. They said, "The majority of MOD contracts are not in the spirit of Frascati and are essentially routine product development involving no appreciable element of novelty." That is from the CBI.

(Mr Mumford) Some routine development would be caught by Frascati. As I said at the outset, my Lord Chairman, we do have in hand some studies of our own. We are aware of the claims made by industry and clearly they are not something we would want or should brush aside as superficial or misguided in any way. We are prepared to sit down with industry and compare figures. Indeed, it may be when we have taken our studies much further forward that we would be in a better position to answer the questions you put to us. The point I would

8 February 1990]

MR W F MUMFORD, MR N H NICHOLLS,
MR D E HUMPHRIES, MR E J LOMAS AND MR P A CROWTHER

[Continued]

[Chairman *contd.*]

like to make is that there is no statistical grounds from the work we have done so far which would justify my telling you that we subscribe to industries' views. We have not reached that stage yet; I would not like to speculate whether we shall.

Chairman] In this connection there is a letter written by Lord Caithness to Lord Shackleton,¹ I do not know if Lord Shackleton understood it very clearly because I do not, in which he explained the subject we are discussing, that is, the discrepancy between what the Ministry of Defence says it spends on research and development through industry and what industry itself says, which you yourself have covered by quoting from a paragraph in the Annual Review on R&D, by saying it was "a distinction between funding and expenditure". I do not know if you want to follow that up?

Lord Shackleton] No, I do not.

Chairman

239. It was not quite clear to us what the difference between funding and expenditure was. It is not a question of what is estimated.

(Mr Mumford) We assumed that he had in mind the factors mentioned in the Cabinet Office Annual Review, that was our understanding. We did not draft his letter. We assumed that was what he had in mind.

240. This does not very accurately reflect that, does it? I think we are mixing up two different accusations, as it were. One is that there is a discrepancy between what the Ministry of Defence says it spends on R&D in industry, and what that industry says they spend on behalf of MOD. That is one issue which you have quoted from the Annual Review of R&D as your explanation of it.

(Mr Mumford) Indeed, yes.

Chairman] But there is this other major issue which is whether or not activities both inhouse and extramural are included in the figures of development which are not properly classified as experimental development under Frascati because they do not contain an innovative element. Those seem to be two different issues.

Lord Kearton

241. I would like to take one or two examples. Let us take the Nimrod programme, for example, in which we spent the best part of a billion pounds. We got no production out of it finally. Was that classed as R&D in your accounts?

(Mr Lomas) I believe it was.

Chairman

242. Because it did not result in production?

(Mr Lomas) Some development will be fruitless.

Lord Kearton

243. Let us take the Chevaline programme, which also cost over a billion pounds. As the end result the actual hardware was very small and, therefore,

presumably most of that billion pounds for Chevaline was classed as R&D?

(Mr Lomas) That did, I think, fall into our net.

(Mr Humphries) There was a substantial amount of innovative work. In a sense, although one is looking back in particular with Nimrod and one might have done things in a different order, there was no doubt about it that a lot of the flying done there was actually discovering things that we did not know about.

Lord Kearton] At the end of the day we are buying the American AWACS and by any definition a billion pounds spent on Nimrod is rather a distortion when we look at the national R&D effort.

Lord Gregson

244. Can you put a percentage on the innovative content of the billion pounds on Nimrod—20 per cent. as the CBI suggest or 50 per cent. as SBAC suggest?

(Mr Mumford) I would not like—

245. Would this not be a better way, to look at what you think is Frascati than waffling the figures?

(Mr Mumford) All I can say is that we are fully aware of the Frascati definitions; they are widely disseminated throughout the Procurement Executive. And that we genuinely and in good faith do our best to extract from our accounting system all the costs of development and research, and record the information that we think is justified under Frascati. We are doing the best we can. We admit that there is scope for refinement, there are problems of classification and indeed things can fall either side of the line. There may well be some understatement and some overstatement. We are conducting some on-going surveys and I hope when these are taken further we are in a better position than now to respond to your question, but they are quite elaborate and complex.

Lord Chorley

246. In the answer to the first question you say that you report on blocks of expenditure and you are driven by the accounting systems and by single contracts, and is this not part of the problem? Obviously an example of a block of expenditure is the whole of Nimrod and it may have lots of stuff which is not innovative at all but has a little something at the beginning which is innovative, and the whole of that accounts for R&D under Frascati. If you were to separate it into discrete bits, albeit they are not contracts, you might get a different answer?

(Mr Mumford) It is Mr Lomas' job to extract the R&D element from the blocks of expenditure, so perhaps it would help if he answered this question.

(Mr Lomas) We extract the data we require for Frascati estimates from our accounting systems. This is basically a two stage process. First of all, it is one of identifying the vote sections which contain R&D contracts or projects, and then, secondly, one of aggregation across those. The identification is the key point of the exercise and for that we do, as best we can, apply the Frascati definitions. But inevitably we are dealing with, generally speaking, fairly sizeable blocks of expenditure.

¹printed after Q 287.

8 February 1990]

MR W F MUMFORD, MR N H NICHOLLS,
MR D E HUMPHRIES, MR E J LOMAS AND MR P A CROWTHER

[Continued]

[Lord Chorley *contd.*]

247. That is my worry.

(*Mr Lomas*) We do our best to go into as much detail as we can to make sure they are truly development contracts, bearing in mind these blocks cover not only the innovative element as such but all the supporting activities which are necessary to make the development contracts operative. So, as I said earlier, in the Frascati manual we do include things like security services for the research establishments, storage use and repair to equipment, which in themselves could not be called innovative but are necessary expenditure to support the research or development. That may be the key difference between our figures and industries' figures. I have no idea how they put theirs together but ours accord to the strict definition of Frascati and include those items.

248. But you have not yet sat down with British Aerospace, for the sake of argument, around a table just to try and identify where the differences are? You may be right but the fact is there is a huge difference of view, and I do not see how you are going to sort it out without getting down into detail with them and seeing what the differences are. To add a supplementary question: it would be interesting to know, and you have mentioned you are studying the thing, what sort of things are emerging out of the study and when you are likely to complete it?

(*Mr Lomas*) Basically we are directing it into two parts. First of all, the intramural research and development, and we are looking very closely at the internal accounting systems of the research establishments and their successor organisations to see what can be extracted to separate out any non-Frascati elements that may be in our figures, and conversely identify any which are not in our figures. So it may be we actually add to our figures in some cases and subtract in others if we find greater information available. That is one area on the intramural R&D. On the extramural, we are first of all looking much more closely at the contracts and the project offices of the major projects to see what elements we may be able to identify from MOD staff of non-Frascati R&D and also Frascati elements which are counted as production in other cases. So we are taking internal MOD knowledge, and it is rather hoped we can talk to industry and see whether we can come to some view from their point of what is Frascati and what is not in the contracts we have let to industry. This is a very long-term process unfortunately and the results will not be available –

Lord Gregson

249. I find it rather strange you are talking in the future tense. The DIC nominated Ivan Yates to sit down and look at this but as far as I can see there has been no report back to NDIC but that is going on. You are supposed to have a working party looking at this, are you not?

(*Mr Mumford*) We have had some informal contacts with British Aerospace.

250. Why talk about it in the future tense?

(*Mr Mumford*) I think Mr Lomas was talking about some more structured, systematic research which we are contemplating. We have had some

exchanges with Ivan Yates and the British Aerospace staff but he had in mind some rather more detailed and systematic studies which are clearly going to be necessary.

Lord Kearton

251. You are spending roughly speaking £2.25 billion a year?

(*Mr Mumford*) Yes.

252. How much of that actually results in anything? Do you have anything over the years to say that of this pre-production stuff we did 20 per cent or thereabouts finally led to something in production? What is the percentage over the years? Any idea?

(*Mr Lomas*) I do not think that is part of our figures. We can look at individual projects and say certain projects have resulted in weapon systems but we cannot within a project say how many times it had to be repeated before they got it right. So some of that development research would have led up blind alleyways and teams have had to retreat before they came to the fruitful part.

253. One tends to get one's information from Select Committees in the other place, but MOD has started many things which have not come to fruition. I wondered if you kept a running total of the total percentage of R&D which results finally in usable hardware?

(*Mr Lomas*) I am not aware of anything.

254. The impression is that it would be a pretty low figure.

(*Mr Humphries*) Something we are doing about it, which should be bringing data more into line in that respect, is that in the wake of some of those programmes we did a study to see how we could do better. One of the things we are now determined to do and are building into our process is to get a key technology survey before we spend too much money. We do not want to go into expensive flight trials before we have proved the thing, a trial in a captive balloon might suffice. By that means we are getting away from a lot of the supporting expenses like the cost of operating an expensive aeroplane to find out something. We will be finding things out in the cheapest way before we launch into the expensive part of putting it in a real aeroplane or ship. Although we have not got the figures you asked for, things as a result of other policies are moving in that direction, where we do not waste money by doing expensive tests and before we have discovered whether the thing works.

Lord Kearton] A lot of the expensive work is not R&D under the Frascati definitions. Some of us have arrived at that feeling.

Lord Shackleton

255. You did use the description non-Frascati R&D, which is a negative definition. Have you a definition for that?

(*Mr Lomas*) That was a slip of the tongue and for that I apologise. I was referring to work which was not calculated to be R&D, which we might have to bring into our figures if we identified it as such. The boundary is drawn in a number of places and some

8 February 1990]

MR W F MUMFORD, MR N H NICHOLLS,
MR D E HUMPHRIES, MR E J LOMAS AND MR P A CROWTHER

[Continued]

[Lord Shackleton *contd.*]

expenditure which should be Frascati may be counted outside the boundary and some inside it. Similarly with production work, some may be inside the boundary and some outside. That is the thing which should be investigated.

Chairman

256. In Table 1.9 of the Annual Review there are two categories under "primary purpose", 8 and 9, for technology transfer on non-Frascati and you have entered nil in each case. However ACOST in looking at how much technology transfer came out of your R&D, said it was about 20 per cent but that is within Frascati you reckon, do you?

(*Mr Lomas*) Yes, the work that we do, my Lord Chairman, on technology transfer is really confined to the defence area. We are only concerned with transfer within the defence area. We do not put expenditure into transfer outside the defence area. That is why we are a zero return.

(*Mr Crowther*) The main point here is that we do not do work specifically for its technology transfer potential. It may have that potential but the primary purpose is for the defence programme.

Chairman] That was made clear in the Government's response to the ACOST report on defence R&D.

Lord Chorley

257. Related to that, Mr Lomas touched on accounting systems and so on. The ACOST report recommended that MOD should publish its R&D data according to the research and development definitions of the Accounting Standards Committee, which was formally known as SSAP13. Is that something you subscribe to?

(*Mr Lomas*) I think in principle, yes, we do.

258. I would be very surprised if you said, no. It is pretty well identical to Frascati. Following on from that, does that mean that you would need to modify your accounting accounts codes and systems in order to more closely capture the novelty element?

(*Mr Lomas*) Indeed, my Lord, that is obviously one of the things we should consider when we have done the first stages of our further study. If it becomes necessary to separate out so-called non-innovative elements then we will have to consider an extension of our accounting system, both inside the development and research area and in the production area. As I said earlier, there are cross-boundary problems. It may be that is the only way we can extract the information on a regular basis without extensive cost.

Lord Chorley] Of course, if the MOD was a plc and was privatised as a plc you would be audited and an auditor would be required to report under SSAP13 on what you spent. I do not know whether that applies to the National Audit Office. I am not sure they are covered by SSAP13, but Lord Gregson probably knows?

Lord Gregson

259. No. I am sure John Bourn would dearly like to see it covered under SSAP13.

(*Mr Mumford*) We are not complaining about being insufficiently audited by the National Audit Office!

260. Could I just follow up a point by Lord Kearton on the question of Chevaline. There are research departments like Aldermaston which do production work. Aldermaston is a particular case in example. Where do you charge that production work? Where is the production work carried out by Aldermaston charged?

(*Mr Mumford*) The production would be in the production vote.

261. Are you sure about that, because I cannot find it and John Bourn cannot find it.

(*Mr Mumford*) It is certainly there. For security reasons it is not separately identified, but it is there.

Chairman

262. Perhaps I could change to rather more general things. You said that you do not see any advantage in perhaps adopting the US Department of Defense method of breaking down research and development expenditure into six different categories; is that because you do not want to change your accounting system, or you think there is some inherent flaw in it?

(*Mr Nicholls*) Every government tends to adopt its own approach towards categorisation of research and development, which is a reflection in part, I suppose, of their accounting procedures, management arrangements and procurement practices. There is a difference and, as Mr Mumford has explained, this emerged very clearly at a workshop he attended a year or so back. So there is no intrinsic merit in adopting another country's practice. Having said that, the American example is quite interesting because it does demonstrate quite clearly the way in which different systems apply in different countries. One can look at it from two points of view: first of all, they call it development, and so one can look at it from the development point of view in the procurement context, and one can also look at it from the aspects of the way in which we categorise our research. The American breakdown is a six-fold breakdown: Research, Exploratory Development, Advanced Development, Engineering Development and Operational Systems Development, plus the Management and Support of their own establishments, which we can exclude. These can be seen to be roughly analogous to what we call the Downey procedures. The Downey procedures define the Department's approach to procurement from the conception of a piece of equipment to its appearing in the inventory. The Downey procedures are devised to ensure that as a project progresses there are opportunities for the Department to look at the work that is being done, satisfy themselves that the project or concept is feasible and satisfy themselves that the technical risk has properly been evaluated, so that when one moves to the next stage one can be reasonably certain that the technical risk will be addressed. We did itemise some of the stages in the answer we provided on this

8 February 1990]

MR W F MUMFORD, MR N H NICHOLLS,
MR D E HUMPHRIES, MR E J LOMAS AND MR P A CROWTHER

[Continued

[Chairman *contd.*]

question. We start off, as you know, with staff coming up with the concept for, let us say, a piece of equipment which will have a particular range and rate of fire and a particular accuracy. That is then worked up into a Staff Target. One then sets in train a Feasibility Study to assess the extent to which the concept is feasible. The next stage is a Project Definition, which normally lasts about two years or so, and is a very important element of the process, before moving to Full Development. These three stages—Feasibility Study, Project Definition and Full Development—roughly match some of the American categories: for instance, Exploratory Development, which is one of the their categories, embraces elements of our Feasibility Study, although it also encompasses work which would precede formulation of the Staff Target. There is some overlap and some similarity, although it is not identical. That is on the development side. On the research side, again, there are similarities between the way the Americans categorise their research and the way we categorise ours. We have eight categories. Exploratory Development, to take an example, appears roughly to encompass work which we designate as category 2 work—that is to say work of immediate and ongoing relevance to existing projects—but also category 4, which is applied research specifically aimed at likely procurement options. I suspect if one looked at the way the Germans or the French or other allies categorised their research and development one could find similar overlaps and similar failure to align. I think what does emerge is that the general approach both to procurement and to research is not dissimilar from the American approach. Having said that, our view is that the American categorisation does not bear directly on the question your Committee, my Lord Chairman, is chiefly pre-occupied with, that is the distinction between innovative and non-innovative research. In sum we do not see any advantage in adopting either the US approach or, for that matter, that of any other allied country.

Lord Flowers

263. Does that mean you do not have any confidence in the categorisation that other countries make, and do not have any confidence in comparisons made between our categories and theirs?

(Mr Nicholls) No, my Lord, I do not with respect make that point. What I am saying is that, for various historical reasons, if you like, we categorise development and research the way we do and other countries do it in a different way but it does not follow that any particular approach to categorisation is necessarily wrong.

Chairman

264. Do you say in the case of, say, Italy and Germany where their defence R&D is very much more integrated with their government-supported civil R&D that therefore comparisons of defence R&D expenditure by Germany, Italy (France is a bit different) and ourselves is really not a good comparison because some of their defence R&D is

hidden in the civil R&D, which makes the civil R&D look larger and defence R&D look smaller?

(Mr Nicholls) It certainly makes it more difficult.

Lord Flowers] It is not a question of whether we do it right and they do it wrong, but whether we do it the same way or do it a comparable way, so that we can make comparisons that are meaningful. It seems to me all this harping on that we do it right is only making it more difficult to have confidence in any comparisons. I have no doubt that the Americans harp on the fact that they do it right and the French ditto.

Chairman

265. It brings us back to why you want R&D figures at all. People want them as an indication of something, an indication of comparisons, and I get back to my original point. Do you feel that the figures which are now available and published in OECD figures for instance—because of the differences in the way we carry out our defence R&D almost totally separate from civil R&D, whereas other countries, and Germany is a very good example, integrate them—distort the whole picture? Would it not therefore be a good thing if we tried and changed our system so we got a true comparison?

(Mr Mumford) I would certainly agree—as indeed the ACOST study recognised—that international comparisons do need to be treated with great caution. They use the phrase “they are fragile”, and I think we agree with that. On the other hand, they are put together by OECD who I imagine do an honest job in producing data which is at least broadly comparable. The second part of your question is whether we should not seek to separate civil and defence R&D?

266. That is a further question, I did not raise that but it is a question I have in mind. Would it not make the whole thing simpler if we did not lump defence R&D with civil R&D so when people were looking at these things the whole picture was not confused by this enormous sum which you claim really to be Frascati development and a great many other people think is not. It does distort the whole figure.

(Mr Mumford) We would still for our own internal MOD purposes wish to classify expenditure in various broad groupings as part of our control mechanisms. I am not sure I feel competent to express a view on aggregation or disaggregation.

(Mr Humphries) The point you have hit upon, that they do things differently in other countries, is really that the statistics tend to reflect the policies towards defence research in those countries. The German situation is that they do support a lot of development of ideas which will later be exploited for defence purposes on a civil ticket. That is their policy to do it that way. We try to attach a true expenditure to the defence objective which it is geared to. It would really mean you would have to take one country's statistics and deliberately try and extract from them something which was not included in them to get a comparable basis. They are actually chosen to reflect the country's policy.

267. Some people have suggested in order to get a truer picture you should look at it from the point of

8 February 1990]

MR W F MUMFORD, MR N H NICHOLLS,
MR D E HUMPHRIES, MR E J LOMAS AND MR P A CROWTHER

[Continued]

[Chairman *contd.*]

view of the number of qualified scientists and engineers you employ in R&D, but most of the answers we have got to that suggestion state that it is not a very good way of assessing the innovative value of your staff. What are your views on that?

(*Mr Mumford*) I think it rather depends what you are seeking in your choice of data. If the emphasis is on the availability of manpower resources for particular purposes, the number of scientifically and technically qualified staff is a major factor. We certainly use allocations of senior scientific personnel—SSPs as we call them—and they are widely used in the MOD to define a particular effort of research and they are a useful indicator. We are the first to recognise that is not an indication of the total resources going into that area; you have to take into account the supporting facilities. A clever scientist cannot operate outside his laboratory, without being in a secure environment in our case, and it is all part of the scenario. We certainly find allocations of SSPs to a particular area are a useful management tool. I would not want to put it further than that.

Lord Gregson

268. You will be aware that OECD have been carrying out a major review of Frascati, where the Cabinet Office was acting as co-ordinator. I presume you have taken part in that?

(*Mr Lomas*) We feed our thoughts through to the statisticians who represent the Government presently in the Central Statistical Office on the usability of the Frascati Manual, so, yes, we are in touch with our statistical colleagues and are having an input to that study.

269. That was only one leg, the other leg was the scientific appraisal of Frascati which was co-ordinated by the Cabinet Office. We have had evidence on this. I presume you have taken part in that part of the exercise, on the quality of the definitions?

(*Mr Humphries*) I am not aware we have. I do not think one can fault the Frascati definitions as ideals to aim for.

270. The British Government have gone further than that, they cannot fault the Frascati definitions and that is what they will stick to.

(*Mr Humphries*) Our problem is associated with—

271. I do not understand why are you hedging all your replies on Frascati, as though it is something the British Government do not like and it is something they wish to push away?

(*Mr Mumford*) No, we say we base our R&D figures on the Frascati definitions. That is not necessarily expressing a view either way. The OECD has been collecting international data on that basis.

Lord Kearton

272. Would you think the Frascati definitions are sensible when it comes to dealing with defence expenditure?

(*Mr Mumford*) We do not rely on them exclusively and entirely for our own internal accounting control purposes.

Lord Gregson

273. Your own internal figures? We couldn't care less about your internal accounting, what about your external accounting?

(*Mr Mumford*) In order to present our R&D figures as a department to the world at large we extract figures as best we can, with our interpretation of Frascati, from accounting blocks of figures which have been devised for our financial control purposes. Our control system was not based on Frascati but we do our best to extract Frascati from it. That is quite an important point.

Lord Flowers

274. You are saying that the Frascati definitions are sufficiently imprecise that you can legitimately allow political considerations, let us say objectives of Government in that sense, to launder very considerably the figures you write down—legitimately?

(*Mr Mumford*) I am not saying that, no. I do not think that interpretation could possibly be put on anything I have said today.

275. You said different countries might interpret—

(*Mr Mumford*) Countries have different systems, my Lords. I do not think they are necessarily influenced by political considerations. We regard this as a statistical exercise or problem for us. We do not think we are injecting policy considerations into it. We try in good faith to do the best job we can to present our figures in accordance with the Frascati definitions.

276. I thought you said other countries did that?

(*Mr Mumford*) I did not actually say that. Did you?

(*Mr Nicholls*) What I said was that other countries have different approaches and there are all sorts of reasons for that. I was not suggesting they were political.

Chairman

277. Perhaps the difference is that what we are saying is that different countries classify certain things which are in aid of defence research under civil research, whereas we are terribly strict in maintaining that all our defence research is carried out through the MOD accounting system?

(*Mr Mumford*) That is right.

278. To go back to this point of the discrepancy between what the MOD says it spends extramurally in industry on defence research and what industry says is spent, the first reason given, which you quoted from the Annual Review on R&D, was that the industrial survey—that is the DTI industrial survey—is directed to enterprises with 200 or more employees but there is no lower limit in the data collected in the Government survey. Have you any indication of how much of your extramural research and development is done in firms with less than 200 employees?

(*Mr Lomas*) We do not have a figure for the research and development expenditure. We have a figure for total procurement.

8 February 1990]

MR W F MUMFORD, MR N H NICHOLLS,
MR D E HUMPHRIES, MR E J LOMAS AND MR P A CROWTHER

[Continued

[Chairman *contd.*]

279. You do not for research and development?
(*Mr Lomas*) No.

280. You do not know how significant it is?
(*Mr Mumford*) We do use a lot of small firms.

281. Yes, but I wonder if there is any way of guessing what proportion is lost in that?

(*Mr Crowther*) About one-eighth of the total procurement expenditure goes to small firms.

Lord Gregson

282. We have had evidence that very few firms with 200 employees do very little R&D at all. They do not do it. The great majority are subcontracted.

(*Mr Mumford*) Yes, but a subcontractor might well be supporting a prime contract which is R&D.

(*Mr Humphries*) I can give an example—although it might be on the borderline of the firms with 200 employees—I visited a year or so ago a firm which was carrying out casting operations and they developed their techniques for some very demanding requirements for the Ministry of Defence. They were able to cast alloys that nobody had cast before with wall thicknesses that nobody had done before. They developed that for the Ministry of Defence. I am sure that the prime-contractor thought it was very ordinary, very trivial stuff but this was, to them, a very important piece of innovative work.

283. That is a very interesting anecdotal account, but what about the other 6,000 firms? If you are referring to figures that you are talking about, £2.5bn, one little company doing one little job is a drop in the ocean. It does not affect the sort of figures we are dealing with. What about the other 6,000 small companies; most of them are subcontract companies.

(*Mr Crowther*) We do know we spend over a million pounds a year specifically on the Small Firm Research Initiative which is directed specifically to provide opportunities for small firms to get involved in research.

284. This is out of the £2.5bn?

(*Mr Crowther*) That is the total R&D budget, £2.3bn; the total research budget, which is the proper comparator here, is some £400m.

Chairman

285. I was going to ask the question: do you see advantage in the figures for civil R&D and the figures for defence R&D being more comparable than they seem to be—but are you maintaining that they are in fact comparable, that you are working on more or less the same definitions and, therefore, they can be compared?

(*Mr Mumford*) The Government certainly seeks to present the R&D figures on a comparable basis in carrying out its Annual Review which is put forward as a composite of figures. I think one does have to recognise that defence R&D serves a different purpose from civil R&D. We are a large procurement organisation. The whole of defence R&D is defence procurement. With the civil departments most of their research activities are in support of where they have sponsorship roles, regulatory roles or statutory roles. Very few other departments have big procurement budgets and responsibilities, so there is a difference there. I suspect that the civil departments perhaps have an easier job in extracting Frascati information than we do. The scale of their research establishments is very much smaller than ours. Certainly the aim of the Cabinet Office on behalf of the Government is to present figures on a comparable basis.

286. You are not prepared to admit that there is a significant element in your development figure which is not properly classified as development under Frascati?

(*Mr Mumford*) No, I have no basis for making such an assertion at this stage.

287. I think we will have to leave it there. Thank you very much, Mr Mumford. I understand this is your swan song?

(*Mr Mumford*) Yes, I am retiring tomorrow.

Chairman] We wish you very well in your retirement. Thank you very much indeed.

8 February 1990]

[Continued

Letter from the Paymaster General (E. Caithness) to Lord Shackleton

Following the oral question in the House of Lords on 5th December (*annexed*) I thought I should write to you about the matter you raised concerning the figures of total UK expenditure on research and development (R&D) and the Ministry of Defence (MoD).

This may relate to a misunderstanding which the Society of British Aerospace Contractors (SBAC) appears to have had when they issued their press notice last year regarding the basis on which UK statistics of total expenditure on R&D are compiled. The SBAC had concluded that the MoD's figures on the *funding* of R&D was not reliable on the basis of a study amongst aerospace defence manufacturers and that this meant that the UK figures for *expenditure* on R&D was unreliable. There are two points here. First that differences in definition in how R&D *funding* is measured make industry/MoD comparisons very difficult. Secondly figures on *funding* and *expenditure* are quite separate (the former being the input into R&D the latter the actual costs) and while these should balance there are great difficulties, not least on differences in definitions, in trying to reconcile the figures.

UK statistics of expenditure on R&D are compiled in accordance with agreed international practice by combining the expenditure of the sectors performing (rather than funding) the R&D on the basis of returns made to the Central Statistical Office from the performers of R&D in government and industry including the MoD. The SBAC's conclusion that the figures on UK expenditure on R&D are unreliable was therefore incorrect.

I hope that this clarifies the situation.

THE EARL OF CAITHNESS

EXTRACT FROM H.L. DEBATES, 5 DECEMBER 1989, C. 737.

R&D: Survey Date

Lord Dormand of Easington asked Her Majesty's Government:

When they intend to conduct their next survey of the research and development carried out by British industry.

The Paymaster General (The Earl of Caithness): My Lords, the next survey of scientific research and development performed by UK industry relates to 1989 and will be carried out during 1990.

Lord Dormand of Easington: My Lords, will the Minister confirm that that is the normal full survey which is carried out every four years by the Government? If so, will the Government consider publishing a full, separate report on the findings? What action are the Government proposing to take on government-funded R&D and that undertaken by private industry in view of two factors? The first is that the amount of R&D has been falling steadily for a number of years now. The second is that we are so behind in research and development in comparison with our overseas competitors.

The Earl of Caithness: My Lords, I can confirm to the House that it will be a fully detailed survey. It will be a benchmark survey covering all enterprises with 200 or more employees. That is one which is carried out every four years. I am not sure where the noble Lord has obtained the figures for the assertion that he has made. But on total expenditure on R&D as a percentage of GDP, we are in the middle of a group consisting of France, West Germany, Italy, Japan and USA.

Lord Shackleton: My Lords, is the noble Earl aware that there are grave doubts about the reliability of the total R&D national figure in particular in relation to the Ministry of Defence? The Select Committee on Science and Technology will shortly be producing a report on R&D and we need to know these figures.

The Earl of Caithness: My Lords, I was not aware of the point that the noble Lord has made. However, I hope that from information provided by the Committee, and that which I shall be able to give him once I return to my office, the noble Lord will have all the data that he needs.

WRITTEN EVIDENCE

Memorandum by the Agricultural and Food Research Council

Responses refer to Questions from the Select Committee, reproduced in Appendix 3 to the Report

1. AFRC returns to the 'Annual Review of Government R&D' use Frascati definitions—there is no choice.
2. Frascati provides only three definitions of research, basic, applied and experimental development. The first two are open to wide interpretation and make no allowance for strategic research which lies at the interface between fundamental research and its application for a specific purpose.
3. AFRC has experienced no difficulty in converting figures for R&D spending into the required format for the Annual Review. However, this is subject to the bias described below.
4. The Frascati Manual is used in interpreting Frascati definitions. The guidelines provided in the manual are not adequate to make clear cut distinctions and the categorisation of R&D spending therefore tends to be entirely subjective and may suffer bias, different individuals making different interpretations depending on their scientific interests or training. Consistency may be achieved within an organisation by employing the same individual to apply the definitions from year to year. This will not resolve differences of interpretation between organisations or between countries.
5. (a) The Frascati definitions do not provide a clear means of differentiating between basic and applied research and are therefore unreliable for purposes (i) to (iv) because of subjectivity of interpretation.
(b) & (c) Clearer means are provided for differentiating between research and development and between R&D and other activities. As stated above, they do not distinguish adequately between different kinds of research and therefore could be misleading when compiling statistics of R&D in any context.
6. This has been explained above. Supplementing the 'basic' and 'applied' research categories with a 'strategic' research category would be a welcome improvement.
7. (a) Basic research Molecular signalling and regulatory mechanisms in animal cells.
(i) The productive capacity of farm animals depends not only on nutritional factors but also on the responsiveness of tissues at the cellular level to regulatory signals which control proliferation and the formation of useful macromolecules. Our basic understanding of the role of these signals in cellular activity is a prerequisite for any attempt to manipulate productive traits by genetic means or otherwise. Two distinct levels of signalling mechanism are presently under investigation:
—Cytoplasmic second messenger systems which are activated in response to events at the cell surface;
—Nuclear DNA sequences which regulate the expression of adjacent genes in response to metabolic signals.
In reality many biological responses may be elicited by a cascade of intracellular signals which pass from the cytoplasmic to the nuclear level.

Titles of other examples are:

- (ii) Molecular interactions between plants and pathogenic fungi
- (iii) Soil properties and composition
- (iv) Virus genome structure and variation
- (v) The physiology and biochemistry of plant/environment interaction in forage crops and cereals
- (vi) Food processing—materials composition and properties: gels, pastes, emulsions, colloids and foams.

b) Applied—strategic Research

- (i) Genetic improvement in the efficiency of production. In animal production, overall efficiency is more important than absolute levels of production per animal. Many components of efficiency are under genetic control and may be improved by selection, breed substitution or breed crossing. However, very little is known about the nature of the genetic control of efficiency itself or about differences in efficiency among breeds and crossbreeding systems. It is important to evaluate efficiency throughout a production cycle. The measurement of efficiency of food utilisation for growth and lactation is therefore an essential part of the assessment of any animal production system. The development of completed pelleted diets has aided this process.

Control of reproduction is an important component of overall production efficiency. The basis of the physiological and biochemical pathways underlying genetic variation is investigated and problems specific to cattle.

Further, full economic assessment of different beef and dairy production systems requires complex systems analysis and it is necessary to establish quantitative genetic and non-genetic relationships needed for computer modelling of production systems.

Titles of other examples are:

- (ii) Biological control of weeds, with pathogenic organisms
- (iii) straw disposal and processing organic wastes with soil animals
- (iv) Molecular biology of Marek's disease
- (v) Grassland production and utilisation in relation to the environment
- (vi) Food processing — process control
- c) None recorded.
- d) None recorded.

8. No difficulty encountered; all R&D spending included in Table 1.22.

9. No, the number of scientifically and technically qualified personnel is not a better indicator of R&D effort than the figure for R&D spending. Different fields of research require quite different investment in scientific manpower as opposed to capital and equipment costs; spending therefore remains the best proxy measure of R&D effort.

18 July 1989

Memorandum by the Chartered Association of Certified Accountants

Thank you for your letter of 19th May regarding R&D definitions on behalf of Sub-Committee II. First of all I will deal with the specific questions in the questionnaire, then the more general questions contained in the preamble to the questionnaire.

Q1 The Frascati definitions are not directly used in the compilation of company accounts. They are used indirectly insofar as they form the basis of the definitions of R&D laid down in SSAP 13. In our opinion very few compilers of company accounts would refer to the Frascati definitions to assist them in deciding how to account for R&D expenditure. However, compilers of accounts should follow generally accepted accounting practice which would involve them referring to the definitions contained in SSAP 13 in cases of doubt. Therefore the revision of SSAP 13 would not have directly affected the use of the Frascati definitions. It has had indirect effects to the extent that the way in which the new definitions are based on Frascati has changed. For example, the Frascati manual refers to applied research as "original investigation". The original SSAP 13 also referred to "original investigation". The revised SSAP 13 refers to "original or critical investigation" thus widening the definitions scope but moving away from the Frascati categorisation. In fact, a detailed examination reveals that in the revised SSAP the definition of pure (or basic) research moves closer to Frascati, the definition of applied research moves further away and the definition of development moves closer.

Variability in the use and understanding of the definitions is therefore dependent on the degree of correspondence between the Frascati definitions and the SSAP, which has been dealt with above, and compilers' use and understanding of the SSAP. Qualified accountants should have a good working knowledge of the SSAP. Therefore the degree of variability in question depends on the correspondences of the original and revised SSAPs to Frascati and on the extent to which preparers of company accounts are suitably qualified; which we believe is high.

Q2 There are many sources that companies can draw on in defining R&D. Organisations have sometimes been recommended to develop their own definitions of R&D activity in a way that best reflects the nature of their business.

However, the definitions of R&D used by companies in their day to day operations must reflect the SSAP13 definitions to the extent that sufficient categorisation and segregation of R&D expenditure is made in their accounting systems to enable accounts using SSAP13 definitions to be drawn up at any time. This constrains the differences in working definitions that companies can use.

Q3 Given the necessary high degree of compliance with the SSAP required, the most relevant explanatory notes and guidance in this area are contained in SSAP13. Following the recent revision of the SSAP they could be judged to be more adequate than previously. More fundamental comments regarding their adequacy are made in the answer to question five below. The degree of subjectivity involved in practice in identifying R&D costs is that allowed by SSAP13. There is clearly a higher degree of subjectivity involved in accounting for costs of innovation not directly dealt with by the SSAP. (Costs of innovation are dealt with in the answer to question five below.)

Q4 The Frascati definitions have provided clear distinctions between categories of R&D to the extent that the definitions derived from them and laid down in SSAP13 provide such distinctions. This has been affected by the revision of the SSAP which has changed the correspondence of the definitions to Frascati (see the answer to question one above)

Criticisms have been made of the definitions. Some of these are detailed in the answer to question five below.

Q5 Amongst the criticisms which have been made of the definitions of R&D in SSAP13, as derived from the Frascati definitions, are the following:

- The scope of the definitions could be broadened to deal with the development of “know how” in the forms, for example, of patented inventions, designs, trademarks or computer software. The revised SSAP specifically excludes a list of items from the definition of R&D including “legal and administrative work in connection with patent applications, records and litigation and the sale and licensing of patents”
- Similarly, and following the example (a) given in the questionnaire, it has been suggested that the SSAP 13 definitions do not address the whole area of innovation rather than the smaller scientific and technical areas of R&D.
- We note the inadequacy suggested in (b) regarding government contract work; notably military work. It has been suggested that since military contract work is a substantial proportion of all development work it should be dealt with and defined as a separate item.

Q6 The main problem with this possible solution is that the number of relevant personnel may not be a good indicator of a company's total financial and other commitment to R&D. For example, it has been suggested that staff costs on average make up 50 per cent. of R&D expenditure. It can be argued that if R&D costs per employee were reasonably constant between companies then numbers of staff could still be a good indicator of a company's financial commitment to R&D. Unfortunately it is not clear that this is so.

A more fundamental problem is that neither numbers of staff nor total expenditure necessarily give a good indication of the quality of R&D work being performed. The quality of R&D commitment can only be assessed retrospectively; often only after lengthy periods have elapsed.

Moving on to your more general questions:

As already stated, the Frascati definitions are used and understood through their derivatives. It can be inferred that they constitute a satisfactory basis for performance to the extent that altered derivatives have been retained in the revised version of SSAP 13. Finally, the SSAP 13 requirements accord closely with the requirements of International Accounting Standard No. 9 “Accounting for Research and Development Activities”. Therefore, where countries follow the requirements of IAS No. 9 there should not be significant differences between their accounting practices in this area. In fact, moves are currently taking place under the aegis of the IASC to increase the International harmonisation of financial reporting. They have proposed that a preferred treatment be laid down of immediately recognising development costs as expenses.

I hope that these answers to your queries prove useful.

Yours sincerely,

Peter Carty

Senior Technical Officer

Memorandum by the Chartered Institute of Management Accountants

1. From your experiences of compiling company accounts, before the recent revision of SSAP13, how widely used were the Frascati definitions of R&D? What degree of variability existed in the use and understanding of the Frascati definitions? What effect will the revision of SSAP13 have on this variability?

The Frascati definitions form the basis of many of the definitions used in both national and international accounting standards.

In the UK, prior to the issue of SSAP13, the general nature of the Frascati definitions enabled different interpretations and presented few restrictions on classification.

It is thought that there is little variability in the use and understanding of the definitions. Most companies are familiar with them and have used them, both for their own purposes and when completing the DTI annual and five-yearly survey of R&D expenditure.

SSAP13 revised has, through the use of illustrative examples, themselves based on international precedents, spelt out in more detail the type of expenditure which may be treated as R&D. As it closely accords with FASB2 in the USA, the detailed guidance provided by that standard may now be applied in the interpretation of SSAP13. The two together provide clear limits to the range of expenditures which qualify as R&D. Further guidance on the treatment of expenditure on R&D for computer software is also provided by FAS86.

2. Are there any differences between the definitions of R&D used by companies in their day to day operations and those used in SSAP13 (revised)? If so do companies experience any difficulty in converting their R&D spending from one set of definitions to the other?

For the purposes of accounting and measurement many companies base their definitions of R&D on those in SSAP13 revised and similar accounting standards. When R&D is being considered by management it is viewed in less defined terms but this rarely leads to any difficulties in reconciling the two.

One area where businesses may have definitions of R&D for use in their day to day operations which differ substantially from SSAP13 revised will be that of market research. Some businesses believe that market

research is an essential part of applied research, as it ensures that there is a market for the product being developed and that it may even be the catalyst for research by identifying a gap in a market.

3. What explanatory notes or guidance do companies use in interpreting definitions of R&D spending for the purpose of compiling company accounts? Are they adequate for this purpose? What degree of subjectivity is involved in identifying R&D costs for the purpose of compiling company accounts?

Most businesses have guidelines on R&D expenditure which normally reflect their overall R&D policies. These are intended to enable control of the actual spend on R&D within the agreed budget.

The degree of subjectivity involved in identifying R&D costs for the purpose of compiling accounts is dependent upon the arrangements within the business for carrying out R&D. Where R&D is carried out in scientific centres involved in little else and separate from production activities, there is normally little difficulty in identifying the costs, and therefore little subjectivity. Where, however, R&D and production activities are carried out in the same place or by the same personnel there is necessarily some subjective judgement required in apportioning costs between the elements of R&D and other activities.

4. Do the Frascati definitions provide a clear means of differentiating between:

- (a) basic and applied research;
- (b) research and development;
- (c) R&D and other related activities;

for the purpose of identifying those costs which should be included as R&D spending in company accounts?

While the Frascati definitions provide a means for differentiating between the three elements of R&D, few companies make the distinction and SSAP13 revised only requires the total figure to be disclosed. However, as development expenditure may be capitalised and research costs have to be written off through the profit and loss account it is possible for expenditure on research and that on development to be separately identified.

SSAP13 revised extends the usage of scientific or technical knowledge beyond production of new or improved materials to installation of new processes and to improvement of those already installed. This now clarifies the important element of "technology transfer" and defines it as development activity. This is particularly important as the sophistication of control engineering and the technical competence required to "transfer" technology increases and there is less distinction between operational setting and process enhancement.

A requirement to separately account for, and disclose, basic and applied research and development would impose a considerable burden on companies and it is hoped that this will never be required. Such subdivisions would also lead to increased subjectivity.

5. What are the specific inadequacies of the Frascati definitions, and how might they be amended? For example it has been suggested that:

- (a) the Frascati definitions are difficult to apply in areas which are not scientific and technological, thereby excluding the saleable products of creative effort in other areas;
- (b) there is a large amount of government contract work, particularly in the defence sector, which is not adequately accounted for in company Annual Report and Accounts.

One of the principal difficulties with the Frascati definitions is that they are often interpreted as being solely applicable to technological and scientific research activities in the industrial and manufacturing sectors. They are rarely seen as applying to services, although this is now made more explicit in SSAP13 revised.

R&D work performed under contract for third parties need not be disclosed in company accounts and this may mean that there is a large amount of such activity which is not reported. While it might be appropriate to consider ways of separately identifying such effort the measure of a company's commitment to its future prosperity is the amount of self-funded R&D and it is the disclosure of this figure that SSAP13 was revised to ensure.

6. In view of the difficulties encountered in classifying R&D costs it has been suggested that a better indicator of a company's commitment to R&D would be the number of scientifically and technically qualified personnel employed rather than the money spend on R&D. Do you agree?

Irrespective of the definitions used there is little doubt that, in practice, R&D is understated in UK company accounts. Even a company which has its own R&D set up will, for example, still have many people engaged in basic production and engineering departments who are carrying out development work on a day to day basis but these are rarely if ever recorded in the R&D expenditure figure.

While it could be that non-monetary indicators such as the number of qualified personnel employed in R&D activity could provide useful information and enable a better comparison between industries, it would still be necessary to define R&D very precisely before staff could be identified. Even then it is unlikely that any meaningful count could be achieved.

Memorandum by the Department of Education and Science**ANSWERS**

Q 1 Yes.

Q 2 No.

Q 3 No problems in converting figures.

Q 4 We use the guidelines provided by the Cabinet Office in Annex 3 to the Annual Review. Additionally we make use of the DTI guidance. More detailed guidance, with examples, on the three research definitions would be helpful. A large number of Branches have to be consulted and individuals may interpret the data differently.

Q 5 Clearer definitions as stated in our response to Q4 would help.

Q 6 It might be useful to have a separate classification for educational research.

Q 7 Examples will have been given by the Research Councils.

Q 8 Much of the Department's research work, excluding the Research Councils, is carried out by educational institutions who are not familiar with Frascati definitions and they have difficulty in allocating monies to the separate categories.

Q 9 The primary purpose definitions are more extensive. However, they do not include a separate category for strategic research. It would be beneficial to have the same definitions across the board.

Q10 No comment.

Q11 No, expenditure is, in our view, a better gauge.

Memorandum by the Department of Employment

1. Do you use the Frascati definitions in making returns to the "Annual Review of Government Funded R & D"? If not what definitions do you use?

Answer—Yes, we follow Frascati definitions in broad terms.

2. Do you use the same definitions in your day-to-day operations, or is it necessary to use other definitions? If so how do these definitions differ from those used in the Annual Review?

Answer—In our day-to-day operations subject areas of research are used. The Frascati definitions are broad but the returns required seem more applicable to R&D in science and technology rather than research in social science. The definitions of applied and development research are only used for the Annual Review returns, with research subject areas highlighted as part of the returns.

3. Do you experience any difficulty in converting your figures for R & D spending into the format required for the Annual Review? Do you encounter any other problems in making returns to the Annual Review?

Answer—Yes, we do experience difficulties in defining subject areas into the format required and problems arise because of the changing nature of subject areas covered by the budgets. The problem of this kind affects only a small proportion of cases.

4. What explanatory notes or guidelines do you use in interpreting the Frascati definitions? Are they adequate for this purpose? What degree of subjectivity is involved in categorising your R&D spending?

Answer—In ED there are no other guidelines used apart from the Frascati definitions listed in Annex 1 to the questionnaire. A paper for Manpower Services Commission (MSC) use was prepared in 1986 as a guideline, which stressed the idea of novelty, and is still in current use in the Employment Service (previously part of MSC). A considerable amount of subjectivity is used in categorising R&D spending, using the Frascati definitions for the Annual Review, because they do not match the day-to-day definitions.

5. Do the Frascati definitions provide a clear means of differentiating between:

- (a) basic and applied research;
- (b) research and development;
- (c) R&D and other related activities;

for the purposes, in each case, of:

- (i) compiling statistics of your department's R&D spending;
- (ii) compiling R&D statistics within a scientific and/or industrial sector;
- (iii) comparing R&D activity between different scientific and industrial sectors;
- (iv) making international comparisons of R&D activity?

Answer—No, there is no clear means of differentiating between the categories and they often merge into each other. This difficulty arises in a small number of projects. We only provide returns for (i) and Frascati definitions are used as requested.

6. What are the specific inadequacies of the Frascati definitions, and how might they be amended? For example, the OECD is considering supplementing the "basic" and "applied" research categories with a "strategic" research category. The United States Department of Defense, sub-divides "experimental development" into "exploratory", "advanced" and "engineering" development (Annex 2). Would there be any advantage in using these, or other, categories to classify your Department's R&D spending?

Answer—A further category supplementing basic and applied research categories would not add to the accuracy of the figures as the returns already split applied into strategic and specific categories. There would be no advantage to us to use the sub-divisions listed and are only relevant to defence research spending.

7. Would you give specific examples of the work funded by your Department in 1986-87 which was recorded under each of the headings in Table 1.22 of the 1988 "Annual Review of Government Funded R&D", i.e.:

- (a) basic;
- (b) applied—strategic;
- (c) applied—specific;
- (d) experimental development.

Answer—Example of Basic Research

No research under this heading.

7. Example of Applied—strategic

Workplace Industrial Relations Survey 2

The surveys have provided information of an essentially factual nature about a broad range of topics within the industrial relations field. The information is required both as essential background information about the state of British workplace industrial relations for the formulation of future government policy and as an indication of the effects of past or current policies. Further analysis of the results of the surveys is ongoing within the Department, by other researchers under contract to the Department and elsewhere via the ESRC Data Archive.

Example of Applied—specific

Careers Teachers and Careers Officers

This project looked at how the rapid changes in the labour market for young people in the last few years have affected the organisation of careers education and guidance, and considered what lessons could be drawn from this with a view to better enhancing the transition from school to work.

Example of Experimental

No research under this heading during the year.

8. Did any of the work funded by your Department in 1986-87 fall outside the Frascati definition of R&D, but within the range of related activities which you have difficulty in distinguishing from R&D? If so would you provide specific examples of those activities which you had difficulty. Was the spending on these activities included in Table 1.22? If not where was it reported?

Answer—ED's return included all research carried out under the external research budget, categorised to fit into the Frascati definitions for the Annual Review only.

9. The "Annual Review of Government Funded R&D" also classifies R&D spending according to "primary purpose". How does this classification differ from Frascati? What advantages, if any, does this classification have over Frascati?

Answer—Our research falls into the "support for policy formation and implementation" category using the "primary purpose" classification. Under the Frascati classification it is applied research.

10. In the "Annual Review of Government Funded R&D" there is an "apparent discrepancy" between the amount that government says it spends on R&D in industry and what industry says it receives from government. How does this situation arise and how can it be improved?

Answer—As the Department is not concerned with this matter, we do not feel able to answer this question.

11. It has been suggested that the number of scientifically and technically qualified personnel employed on R&D is a better indicator of R&D effort than is the figure for R&D spending. Do you agree?

Answer—No, this would not be a more accurate indicator. It would be difficult to list the qualifications of all the researchers used by our contractors i.e. Universities, private researchers. With research studies varying between 3 months and 3 years it would not be an accurate reflection of R&D effort and would not pick up the manpower required in large scale survey work which is a major part of the research budgets.

Memorandum by the Department of Energy

Q1 Do you use the Frascati definitions in making returns to the "Annual Review of Government Funded R&D"? If not, what definitions do you use?

Yes.

Q2 Do you use the same definitions in your day-to-day operations, or is it necessary to use other definitions? If so, how do these definitions differ from those used in the Annual Review?

Not necessarily. Our programmes focus on particular objectives, and it is often the case that the activities involved can be beyond the Frascati definition—into technology transfer, or some areas which are in neither of these recognised categories. For our day-to-day purposes, we do not attempt to split expenditure into these particular categories, but focus on the sectors involved.

Q3 Do you experience any difficulty in converting your figures for R & D into the format required for the Annual Review? Do you encounter any other problems in making returns to the Annual Review?

In general, no; but, for some programmes, there may be problems in disaggregating expenditure into the various categories. We also have some problems in allocating expenditure to primary purpose—some programmes may lend themselves to more than one p.p. For example, the rationale of our fusion programme is pp 2 (support for policy formation), but it contains elements of pp 1 (advancement of science).

Q4 What explanatory notes or guidelines do you use in interpreting the Frascati definitions? Are they adequate for this purpose? What degree of subjectivity is involved in categorising your R & D spending?

We use the guidelines issued with the forms for the Review, which are sufficient for the purpose. There is a considerable degree of subjectivity in the categorisation of R & D spending, particularly where the actual content of a programme is changing over time (for example, as it moves from research to development). Further, the "strategic" research category has caused some confusion, since that word has different connotations in the energy policy sense from those meant in the Frascati definition.

Q5 Do the Frascati definitions provide a clear means of differentiating between:

- (a) basic and applied research;
- (b) research and development;
- (c) R & D and other related activities;

for the purposes, in each case, of:

- (i) compiling statistics of your Department's R & D spending;
- (ii) compiling R & D statistics within a scientific and/or industrial sector;
- (iii) comparing R & D activity between different scientific and industrial sectors;
- (iv) making international comparisons of R & D activity?

The Frascati definitions enable us to differentiate as far as we need to—principally between things which are R & D and those which are not. As our programmes are objective-oriented, this distinction is made primarily for outside purposes, such as the Annual Review. Statistics on the Department's R & D expenditure commonly reflect the Department's Estimates figures, which contain elements of Frascati R & D, technology transfer, and activities which are science-based but fit into neither of these categories (principally our offshore geology programmes). The Frascati definitions do, however, offer some assistance in making international comparisons, although some caution is needed in considering such figures, which can often be significantly affected by external factors such as exchange rate movements.

Q6 What are the specific inadequacies of the Frascati definitions, and how might they be amended? For example, the OECD is considering supplementing the "basic" and "applied" research categories with a "strategic" research category. The US Department of Defense subdivides "experimental development" into "exploratory", "advanced" and "engineering" development. Would there be any advantage in using these, or other, categories to classify your Department's R & D spending?

As already mentioned, some of our activity which is classified for Estimates purposes as R&D, falls out—with the Frascati definition, and our Departmental entry in the 1989 Annual Review is therefore on a different basis to that in our Estimates. To some extent, therefore, the Frascati figures understate the amount of science-based activity which we undertake. That said, we see no real benefit in splitting up R&D expenditure into more categories: given that any set of definitions will have grey areas at the margins of the chosen categories, then an increase in the number of categories will simply produce a greater aggregate area of grey across the same range of programmes. We see no particular benefit in adding to the task of making returns.

Q7 Would you give specific examples of the work funded by your Department in 1986-87 which was recorded under each of the headings in Table 1.22 of the 1988 Annual Review, ie:

- (a) basic;

No whole programmes — but elements of some programmes, such as fusion, may involve some basic work

- (b) applied — strategic;
 - Fusion, and our contribution to the UKAEA's underlying research programme
- (c) applied — specific;
 - Tidal power environmental studies
 - Inshore wave energy device on the island of Islay
 - Mechanistic studies of foam flow in porous media (part of enhanced oil recovery programme)
- (d) experimental development.
 - Tidal power engineering development
 - Construction of Richborough wind turbine
 - Effect of pile-driving on fatigue life

Q8 Did any of the work funded by your Department in 1986-87 fall outside the Frascati definition of R&D, but within the range of related activities which you have difficulty in distinguishing from R&D? If so, would you provide specific examples of those activities with which you had difficulty. Was the spending on these activities included in Table 1.22? If not, where was it reported?

As already mentioned, some of the Department's work which is classified as "R&D" for estimates purposes falls outwith the Frascati definition. Some of these activities are technology transfer, some can only be classified as "other". Examples of the former are the Energy Efficiency Demonstration Scheme and the Renewables Technology Transfer programme; and of the latter, our offshore geology and reservoir simulation programmes and the EEO's Monitoring and Targeting programme. Spending on these items is not listed in the Annual Review tables, but is reported in the Departmental text.

Q9 The Annual Review also classifies R&D spending according to "primary purpose". How does this classification differ from Frascati? What advantages, if any, does this classification have over Frascati?

The classifications are quite different: primary purpose seeks to explain why we are doing something, while Frascati shows the kind of work being done. There is no advantage of one over the other, since they are looking at different aspects of the same thing. The primary purpose classifications may be useful in looking at the fundamental objectives of research across Government; but we do not use them at all in our day-to-day work.

Q10 In the Annual Review there is an "apparent discrepancy" between the amount that the Government says it spends on R&D and what industry says it receives from Government. How does this situation arise, and how can it be improved?

There is an explanation of some of the possible reasons for these differences in the 1989 Annual Review.

Q11 It has been suggested that the number of scientifically and technically qualified personnel employed on R&D is a better indicator of R&D effort than is the figure for R&D spending. Do you agree?

Manpower figures are a valid indicator (and probably an underused one) which is a useful addition to (but not a replacement for) expenditure figures. It addresses the same issue, but from a different angle; and may therefore occasionally throw some useful light on particular problems.

Memorandum by the Department of the Environment

You have invited DOE comments on the Frascati 'definitions'. The objectives of the Department's research are laid out in the Annual Review, and largely follow the needs to inform Departmental policy. Comparative international statistics are not much used by the DOE in this context, nor are the definitions basic, strategic or applied. Much more importance is attached to the longitudinal record of the Department's expenditure as recorded in the Annual Review. The only 'taxonomy' which is operative is whether the activity funded is a proper charge to the appropriate research Vote Sub-Head.

Returns to DTI on DOE's research expenditure for inclusion in the Annual Review of Government Funded R&D are made by CSG (Chief Scientist Group) in the Department based on the Department's voted expenditure for research but adjusted for some technical accounting aspects as required by the Annual Review eg. the inclusion of superannuation costs for intramural research. CSG is staffed by professionals, all of whom have had considerable research experience, are familiar with the Frascati definitions and act as reliable vetting points for the Department's research. While the Frascati definitions are not applied routinely by CSG, either for the Annual Review or for other purposes, the approach is to start with the core Frascati definition, namely: "Research and experimental development (R&D) comprises creative work undertaken on a systematic basis in order to increase the stock of knowledge, including knowledge of man, culture and society and the use of this stock knowledge to devise new applications".

One difficulty presents itself to DOE on Frascati definitions. This is their exclusion of survey data. Important social and environmental research could not be conducted unless long term time series had been collected. However this resource, unlike hardware, is not recorded in the statistics. A number of recent

difficulties in maintaining national resource data bases may suggest that research councils are pressured by the implication of the Frascati definitions as to what constitutes a proper 'research' activity.

I attach answers to the Committee's specific questions. I am copying these with a copy of this letter to Mr Packer CPPU.

Yours sincerely

D J Fisk

Chief Scientist

Q1: Do you use the Frascati definitions in making returns to the 'Annual Review of Government Funded R and D'? If not what definitions do you use?

The Department uses the core Frascati definition (c.f. the first paragraph of the Introductory Remarks) in making returns to the 'Annual Review of Government Funded R and D'. The Frascati definitions are in fact slightly modified for use in the Annual Review (see Annex 3 of the 1988 Review).

Q2: Do you use the same definitions in your day-to-day operations, or is it necessary to use other definitions? If so how do these definitions differ from those used in the Annual Review?

The definition used in the DOE's management of its programme relates to whether the activity concerned is a proper charge to the relevant vote sub-head.

Q3: Do you experience any difficulty in converting your figures for R and D spending into the format required for the Annual Review? Do you encounter any other problems in making returns to the Annual Review?

The only major difficulty (indicated by recent revisions) has been the identification of the full overheads of in-house research.

Q4: What explanatory notes or guidelines do you use in interpreting the Frascati definitions? Are they adequate for this purpose? What degree of subjectivity is involved in categorising your R and D spending?

The Department has not found the need for explanations beyond the Frascati definitions. The categorisation of R and D spending is based solely on the judgement of professionals in the Department.

Q5: Do the Frascati definitions provide a clear means of differentiating between:

- (a) basic and applied research;
- (b) research and development;
- (c) R and D and other related activities;

for the purposes, in each case, of:

- (i) compiling statistics of your Department's R and D spending;
- (ii) compiling R and D statistics within a scientific and/or industrial sector;
- (iii) comparing R&D activity between different scientific and industrial sectors;
- (iv) making international comparisons of R&D activity?

The Frascati definitions, while somewhat cumbersome, do provide a basis for compiling statistics of the Department's research programme.

Q6: What are the specific inadequacies of the Frascati definitions, and how might they be amended? For example, the OECD is considering supplementing the 'basic' and 'applied' research categories with a 'strategic' research category. The United States Department of Defense sub-divides 'experimental development' into 'exploratory', 'advanced' and 'engineering' development. Would there be any advantage in using these, or other, categories to classify your department's R&D spending?

The section on general purpose data collection appears too restrictive in its ideas of what data collection can legitimately contribute to research.

The supplementing of the 'basic' and 'applied' research categories with a 'strategic' research category would be useful subject to a satisfactory definition being agreed within the research community.

Q7: Would you give specific examples of the work funded by your department in 1986-87 which was recorded under each of the headings in Table 1.22 of the 1988 'Annual Review of Government Funded R&D', i.e:

- (a) basic;

The Department does not pursue basic research. The item recorded against DOE in the Table relates to a small part of the programme of the Sports Council, a body for which DOE is the parent Department. An example project within this programme entailed the development of a technique for accurately charting of people's leisure interests and patterns through their lives to enable a better understanding of the dynamics of participation.

(b) applied—strategic;

'Lake Acidification in the United Kingdom'. This project followed on from an earlier study of the acidification of Galloway lakes. The project was intended to establish if and how acidification was occurring in lakes with similar chemistry in other parts of the United Kingdom. The basic approach of the research comprised obtaining and analysing lake sediment cores. The objectives of the research was to reconstruct the chemical history of selected lakes and to evaluate hypotheses with differing emphases on catchment area and atmospheric influence. The strategic objectives was to establish a sound understanding of the causes and effect of acidification to assist the development of environmental protection policy.

(c) applied—specific;

'Effects of Distribution on Organic Contaminants in Potable Water'. The objective of this project was to determine the effect of water supply systems on organic contaminants present in finished water and to determine the effects on the organic content of the distributed water from materials of construction and pipe lining materials. The results of this research has led to a better understanding of the nature and behaviour of organic compounds during distribution and more appropriate use of new materials of construction, modified maintenance procedures, in particular the specification of in-situ applied epoxy resin relining, and to a clearer understanding of where to monitor treated water.

(d) experimental development.

'Geotechnics and Buildings'. The Building Research Establishment have developed various special instruments to examine the long-term performance of full-scale building foundations and other geotechnical constructions. The objectives were twofold: to provide information for design codes of practice to ensure the safe working of such constructions, and to indicate the potential for economies in design.

Q8: Did any of the work funded by your department in 1986-87 fall outside the Frascati definition of R and D but within the range of related activities which you have difficulty in distinguishing from R and D? If so would you provide specific examples of those activities with which you had difficulty. Was the spending on these activities included in Table 1.22? If not where was it reported?

None of the work funded in 1986-87 under the research sub-heads of the Departmental Voted expenditure and included in Table 1.22 fell unequivocally outside the Frascati definitions of R and D. Those activities included in Table 1.22 close to the boundaries of the Frascati definitions were those including survey and monitoring work. Examples of such studies are:—

(a) The 1986 English House Conditions Survey. The survey has four parts:

- (i) A physical survey of a sample of the country's housing stock, with the particular aim of assessing the condition of the stock and how this changes over time.
- (ii) An interview survey with the occupants of surveyed housing, seeking socio/economic information about what they may have done or intend doing to their property, what the work might cost, how it might be financed etc. and also attitudes to work associates with energy conservation.
- (iii) A postal survey of local authorities, seeking information about any action which they might have taken on the surveyed properties, whether in the public or private sector.
- (iv) A house value survey, aimed at assessing the value of the sample included in the physical survey.

Measurement of Radiatively Important Trace Gases. The study essentially involves monitoring, over a period of time, the rates of increase in concentrations of methane, nitrous oxides and 5 halocarbons and from the data obtained, calculating the rates of emission and chemical destruction of halocarbons. The study constitutes part of the Global Atmospheric Gases Experiment (GAGE) designed to determine the global magnitude and latitudinal distribution of the surface source of methane and other greenhouse gases.

Q9: The 'Annual Review of Government Funded R and D' also classifies R and D spending according to 'primary purpose'. How does this classification differ from Frascati? What advantages, if any, does this classification have over Frascati?

The primary purpose classification is intended to differentiate between the different purposes for which research is undertaken. It matches the Frascati definitions in distinguishing between basic and applied research, but whereas for applied research Frascati addresses the question "is it research?" and explores this question against a range of type of activity; Primary Purpose address the question "what is the research for?"

Q10: In the 'Annual Review of Government Funded R and D' there is an "apparent discrepancy" between the amount that government says it spends on R and D in industry and what industry says it receives from government. How does this situation arise and how can it be improved?

This question is for Cabinet Office and DTI.

Q11: It has been suggested that the number of scientifically and technically qualified personnel employed on R and D is a better indicator of R and D effort than is the figure for R and D spending. Do you agree?

No. This would give no measures of the true resources used or its quality.

Memorandum by the Department of Health

I am responding to your letter of 19 May to Miss Wears about the questionnaire prepared by the Select Committee on Science and Technology about the definitions of R&D. The answers to the Sub-Committee's questions are as follows.

1. Yes.
2. In general when definitions are needed in day to day operations, yes. The exceptions are that the Procurement Directorate needs to distinguish R&D from the evaluation of medical equipment, and the Public Health Laboratory Service Board more usually considers R&D under the categories of Methodology, Epidemiology and Prevention.
3. There were no major difficulties in converting the figures into the required format for making returns. The problems encountered are unfamiliarity with the return forms and the time involved in completing them.
4. The guidelines accompanying the Annual Review Forms are used in interpreting the Frascati definitions.
5. The Frascati definitions are considered to be generally satisfactory, although for purpose (i), the definitions do not provide a particularly clear means of differentiation of categories (b) and (c).
6. The suggested amendments are not considered helpful.
7. Examples of work funded by the Department of Health under each of the research headings in Table 1.22 are as follows:
 - (A) Basic — none
 - (B) Strategic — The study of effect of fire and smoke in the health care environment
— Molecular virology of HIV
 - (C) Specific — Development of Electrical Impedance Imaging
— Development of a monitoring system for post-operative management of cardiac surgical patients
 - (D) Experimental Development — Experimental Dosimetry Development of a knowledge based system for interpreting laboratory data.
8. A small number of projects are labelled as “non-Frascati”. These are not included in the returns made for the Annual Review.
9. Primary Purpose as its name implies is a classification by the purpose of the research, whereas Frascati is a classification system by type of research.
10. No applicable to Department of Health.
11. We agree that the number of qualified personnel employed on R&D is a good indicator of R&D effort. However, the figure for R&D spending takes into account both the staff and other elements eg capital equipment and consumables. It is our opinion therefore, that figures on both aspects would give a better indication of R&D effort.

I hope that this is helpful. However, should you require any further information on this subject, please feel free to contact me.

Yours sincerely

D. M. Woolley

Research Management Division

Memorandum by the Department of Social Security

1. Yes, we use the Frascati definitions in making returns to the “Annual Review of Government Funded R&D.”
2. Since all the research we undertake is applied research, we do not use the definitions in our day-to-day operations.
3. We do not experience any difficulty in converting our figures for R&D spending into the format required for the Annual Review, nor do we encounter any other problems in making returns to it.
4. We do not use any guidelines other than those reproduced in Annex 3 of the Annual Review. We find them quite adequate. We do not find the need to be subjective in categorising our R&D spending.
5. We do not find the use of Frascati relevant for the purposes of compiling statistics or making comparisons because we are involved in only one type of research activity.

6. We do not feel that this question is relevant to us because of the restricted nature of our activity.
7. All the work funded by us fell under the heading "applied strategic".
8. None of the work funded by this department fell outside the Frascati definition.
9. The Frascati definitions are simpler than the definitions of primary purpose. The only advantage the primary purpose definitions may have over Frascati is that they define the aim of the research rather than the type.
10. This question is not relevant to us.
11. The number of qualified personnel employed on R&D is not necessarily a better indicator of R&D effort than is the figure for R&D spending because the number of people engaged in research does not reflect the full cost. In this Department most of the research is undertaken for us by outside organisations. For us, therefore, the amount of spending is a better indicator of our efforts than the number of qualified personnel employed by the department. The best indicator would be a combination of both spending and personnel.

First Memorandum by the Department of Trade and Industry

Q1. Are the Frascati definitions used by the following for the purpose of making returns to the 'Annual Review of Government Funded R&D':

- (a) civil government departments;
- (b) the MoD
- (c) the Research Councils and the UFC
- (d) industry (via the DTI survey of Industrial R&D)

If not, what definitions do they use?

A. All central Government bodies in their returns to the Annual Review of Government Funded R&D are asked to follow the Frascati definition. All firms reporting in the survey of industrial R&D are asked to follow the Frascati definition. As far as we are aware this practice is followed by respondents. We understand that the Ministry of Defence is currently looking at the degree of novelty involved in their development contracts. Within research councils there are sometimes difficulties in deciding upon the borderline between basic research and strategic applied research. In the case of industry some firms find difficulty in the borderline between applied research and experimental development.

Q2. Are you aware of any differences between the Frascati definitions and the definitions used by the above organisations in their day-to-day operations?

A. DTI follow different definitions in their day to day operations (see other DTI response). Apart from that we are not aware of any differences between the Frascati definitions used in reporting to us and the practices in various organisations listed in 1 above. However we would have no reason to be made aware of such differences unless they had relevance to the returns which we obtained from respondents. In the case of industry the application of accounting standard SSAP13 should help maintain the correspondence with the Frascati definition in industry.

Q3. Do respondents to the Annual Review/DTI survey experience any difficulty in converting their figures for R&D spending, into the format required for the Annual Review/DTI survey? Are you aware of any other problems that respondents have in making returns to the Annual Review/DTI survey?

A. The main complaint of respondents to the Annual Review is the amount of work involved in providing the information. We are sometimes asked to clarify certain points with respondents but we have not been made aware of any major difficulties experienced by respondents to the Annual Review and the survey of industrial R&D.

Q4. What supporting explanatory notes and/or guidelines do you provide in order to ensure a consistent interpretation of the Frascati definitions? Are they adequate for this purpose? How well do respondents to the Annual Review/DTI survey understand the concept of an "appreciable element of novelty," which is at the heart of the Frascati definitions?

A. Explanatory notes are provided in both the industrial survey and the Government survey. They are intended to make clear what activities are within scope of R&D and what activities are outside it. They appear to be well understood though as was mentioned in the answer to Question 1 the Ministry of Defence is currently examining the question of the degree of novelty involved in the development contracts. In the case of social science for example respondents appear to be clear about the distinction between research into training methods which is within scope of the Frascati definition and training itself which is not. With industry using the definitions of SSAP13 from 1989 this should tend to reinforce the Frascati definitions within industry.

Q5. What is the accuracy of returns to the Annual Review/DTI survey? What degree of subjectivity is involved when respondents categorise their R&D spending according to the Frascati definitions? Is it possible to attach confidence limits to these figures, ie. $\pm 5\%$, or 10% or 20% ? How reliable are apparent trends from a particular source?

A. We do not know of any important degree of subjectivity involved when respondents make returns in the Annual Review. As we have complete coverage of central Government expenditure there is no meaning in attaching confidence limits to the figures. They do not form part of a probability sample. Changes in coverage which are usually noted such as for example the Atomic Energy Authority leaving the Government sector and joining the industrial sector affects the figures but apart from that the movements should be reliable.

In the case of the industrial survey there is a benchmark survey every four years and a sample survey in other years. Except for private industrial firms employing less than 200 which are not included, there is full coverage in the benchmark survey so that broadly the same consideration applies as to the Government survey. In other years there is a panel survey of the larger businesses accounting for about 75 per cent. of the total expenditure on R&D performed in UK industry in the latest benchmark year. The response to the survey is complete. The larger businesses which account for most of the expenditure on R&D are covered every year and the smaller businesses which together accounted for 25 per cent. of expenditure on R&D are covered every four years. Consideration is being given to increase the sample size in future years.

Q6 What factors limit the accuracy of the R&D statistics? For example, it has been suggested to the Sub-Committee that the accuracy of industrial R&D statistics is affected by the failure to record the R&D activities of small firms.

A Industrial firms employing 100 to 200 persons were last included in the 1975 industrial survey of R&D. Their contribution to the total was less than $\frac{1}{2}$ % which suggests that the absence of small industrial firms on the grounds of the form filling burden, is not an important issue.

Q7 Do the Frascati definitions provide a consistent means of differentiating between:

- (a) different basic and applied research;
- (b) research and development;
- (c) R&D and other activities;

for the purposes, in each case, of:

- (i) compiling statistics of R&D activity within a scientific or industrial sector;
- (ii) compiling R&D statistics across the whole of the UK economy;
- (iii) comparing R&D activity between the private and public sectors (civil);
- (iv) comparing R&D activity between the private and public sectors (defence);
- (v) making international comparisons of R&D activity?

A In principle the Frascati definitions provide a consistent means of differentiation. In practice some of the Research Councils have difficulty in deciding where basic research ends and strategic applied research begins. Some respondents to the industrial survey have difficulty in separating applied research and experimental development. In the case of social science the R&D information is probably less reliable than for R&D in general because of the difficulty of distinguishing between social science R&D and related activities such as information services and general purpose data collection. It is not possible to distinguish total R&D between civil and defence purposes because while that performed within Government is subdivided between civil and defence purposes, R&D performed in industry is not subdivided in that way. Consideration is being given to doing this in the 1989 industrial survey to be carried out in 1990.

Q8 What are the specific inadequacies of the Frascati definitions, and how might they be amended? For example the OECD is considering supplementing the categories of 'basic' and 'applied' research with a 'strategic' research category. The US Department of Defence subdivides 'experimental development' into 'explanatory', 'advanced' and 'engineering' development (Annex 2). Would Frascati be improved by the use of these categories? Would there be any advantages in the use of these, or other, categories to classify R&D spending in the Annual Review/DTI survey?

A The main purpose of revision to the Frascati Manual is to bring it up to date in the light of developments since the Manual was first produced. The question of what is research and development in software is important in this respect. It is not clear that there are any other important shortcomings. There should be good reasons for any additions to the manual.

Q9 In the 'Annual Review of Government Funded R&D' there is an "apparent discrepancy" between the amount that Government says it spends on R&D in industry and what industry says it receives from Government. How does this situation arise and how can it be improved?

A Page 34 of the 1988 Annual Review gives the reasons for the differences between the Government expenditure in industry and industry receipts from Government. This occurs in other OECD countries. Total expenditure on R&D is built up by sector of performer of R&D according to the Frascati definition. It follows that to be consistent the funding of it should be obtained from the sector of the performed R&D. This does mean of course that the recognition of central Government as the ultimate source of funds may not be known to some firms performing R&D in industry. On the other hand in a Government contract for industry involving both R&D and production, how much of the contract is R&D and how much is production may not be as clear to those spending the money in Government as to those performing the R&D in industry.

Q10 In view of the “apparent discrepancy” mentioned above and the fact that the information contained in Table 1.3 of the Annual Review is “not directly comparable” with other information in the Annual Review, are the figures for R&D spending a reliable basis for science policy making in the UK?

A The purpose for which the information is needed must be considered when dealing with comparisons of information on research and development. If total expenditure on R&D in an economy is to be measured it must be done on the basis of the sum of the sectors performing the R&D as is laid down in the Frascati Manual. This will give a reliable basis for comparing with other OECD countries. On the other hand if the concern is the different purposes of expenditure by Government then the information on Government funding should be used. If a potential user is uncertain he should consult the statisticians involved. This is the same approach used in OECD countries.

Q11 In the Annual Review R&D spending is also classified according to “primary purpose”. What is the purpose of this classification and how does it differ from Frascati? Does it have any advantage over Frascati? What emphasis do/should users of R&D statistics place on the different methods of classification?

A The primary purpose is an analysis of Frascati R&D according to the reason for the expenditure on R&D. The other sub-divisions of R&D, basic, applied, experimental development, analyse the type of activity carried out. There are two different ways of analysing the same total.

Q12 It has been suggested that the number of scientifically and technically qualified personnel employed in R&D is a better indicator of R&D effort than is the figure for R&D spending. Do you agree?

A Personnel information and expenditure information are both useful in estimating effort on R&D. They are related as the cost of personnel is part of the expenditure on R&D. One measures resources used in employment terms. The other measures resources used in terms of the total value of the inputs on R&D, both personnel and other costs.

Q13 In what ways could the ‘Annual Review of Government Funded R&D’ be improved? For example, several other countries include effectiveness measures (ie output indicators) in their reviews of R&D spending.

A The 1989 Annual Review is to contain more information on personnel than in previous years. It will contain data on first destination of employment of those obtaining first degrees in science and technology in Great Britain. It will also contain information on academic staff in Universities employed in science and technology. Some output indicators like overseas receipts and payments for technological royalties and exports and imports of high technology goods are fairly well developed. They may not fit the current structure of the Annual Review very well. Others like citations analysis in publications are less well developed and there are problems of interpretation. The question of the inclusion of other indicators is kept under review.

Q14 It has been suggested that the main problem with the UK R&D statistics lies not in their quality but in the lack of resources devoted to their collection. Do you agree? What impact will the reorganisation of the Central Statistical Office have on the collection and presentation of UK R&D statistics?

A Government policy is to minimise the resources taken up by the public sector in the economy and the collection of statistics must conform with this policy. It is also Government policy to minimise the form filling burden on industry by the collection of statistics. Within these constraints during the 1980s the resources devoted to R&D statistics have been maintained although the demands made on these resources have increased considerably. The reorganisation of the Central Statistical Office (CSO) is really a matter of a switch in Ministerial responsibility for UK R&D statistics from DTI to HM Treasury. The resources and expertise on the subject will be maintained in the CSO and the publication of the information on R&D will continue.

Second Memorandum by the Department of Trade and Industry

1. Do you use the Frascati definitions in making returns to the Annual Review of Government Funded R&D? If not what definitions do you use?

A. Yes.

2. Do you use the same definitions in your day-to-day operations, or is it necessary to use other definitions? If so how do these definitions differ from those in the Annual Review?

A. No, we do not use the definitions in day-to-day operations. DTI S&T expenditure is classified according to the various separate budgets involved, e.g. for innovation, aeronautics, space, research establishments etc — which include non-Frascati expenditure. However the Frascati definitions are familiar to those involved with these budgets and there is an awareness of those items which fall within the definitions and those which do not.

3. Do you experience any difficulty in converting your figures for R&D spending into the format required for the Annual Review? Do you encounter any other problems in making returns to the Annual Review?

A. There is no difficulty in principle. The Annual Review process has now been in place for a sufficient length of time for those concerned to be well aware of and able to provide what is required. In practice there is a lot of work involved simply arising from the very large number of individual projects supported by DTI. (There are for instance, currently some 2,000 projects involving expenditure under the industrial innovation heading.)

4. What explanatory notes or guidelines do you use in interpreting the Frascati definitions? Are they adequate for this purpose? What degree of subjectivity is involved in categorizing your R&D spending?

A. Those provided with the Annual Review return forms, which are generally understood within DTI, and which are satisfactory. A certain amount of subjectivity inevitably arises because approximations are necessary to cope with the large number of projects mentioned above.

5. Do the Frascati definitions provide a clear means of differentiating between:

- (a) basic and applied research;
- (b) research and development;
- (c) R&D and other related activities;

for the purposes, in each case, of:

- (i) compiling statistics of your department's R&D spending;
- (ii) compiling R&D statistics within a scientific and/or industrial sector;
- (iii) comparing R&D activity between different scientific and industrial sectors;
- (iv) making international comparisons of R&D activity?

A. In respect of the first purpose mentioned i.e. compiling statistics for DTI's spend, the Annual Review uses a modified Frascati definition which seeks to differentiate between applied research with strategic and specific aims respectively. Within DTI, it is not apparent that those making returns find difficulty in categorizing their activities under the four headings of basic research, strategic and specific applied research and development. DTI is not involved in purposes ii, iii and iv.

6. What are the specific inadequacies of the Frascati definitions, and how might they be amended? For example, the OECD is considering supplementing the "basic" and "applied" research categories with a "strategic" research category. The United States Department of Defense sub-divides "experimental development" into "explanatory", "advanced" and "engineering" development (Annex 2). Would there be any advantage in using these, or other, categories to classify your department's R&D spending?

A. As indicated above, the Annual Review already uses a modified category of 'strategic' research. On the whole, the Frascati definition seems reasonably adequate and now has the advantage of being widely understood and applied worldwide. We do not see any particular advantage in the US Department of Defense categories. There are apparently some areas of doubt being discussed within the OECD arising from the growing effort on areas of work such as software which were of much less significance at the time the Frascati definitions were introduced. There is thus some need to up-date the detailed definitions.

7. Would you give specific examples of the work funded by your department in 1986-87 which was recorded under each of the headings in Table 1.22 of the 1988 'Annual Review of Government Funded R&D', i.e.:

- (a) basic;
- (b) applied — strategic;
- (c) applied — specific;
- (d) experimental development.

A. (a) None;

- (b) Alvey projects;
- (c) Radio regulatory research;
- (d) Electronic applications projects.

8. Did any of the work funded by your department in 1986-87 fall outside the Frascati definition of R&D, but within the range of related activities which you have difficulty in distinguishing from R&D? If so would you provide specific examples of those activities with which you had difficulty? Was the spending on these activities included in Table 1.22? If not where was it reported?

A. Quite a significant proportion (£99.2m) of the work funded from DTI's S&T budget in 1986-87 fell outside the four categories of Frascati expenditure which are reported in Table 1.22. They were separately reported in Table 10c as non-Frascati expenditure and DTI has made a practice of doing this in recent years. As indicated in 2 above, DTI has no difficulty in identifying S&T activities which lie outside the scope of the Frascati definition.

9. The 'Annual Review of Government Funded R&D' also classifies R&D spending according to 'primary purpose'. How does this classification differ from Frascati? What advantages, if any, does this classification have over Frascati?

A. The categorization of Government supported work into primary purposes (as defined in the 1989 Annual Review, Annex 2) is quite different to the Frascati classifications, seeking as it does to identify expenditure in terms of ultimate government aims. The primary purposes are thus not directly comparable to the Frascati definitions and should be regarded as a complement to them (which provides additional information), rather than as a substitute for them.

10. In the 'Annual Review of Government Funded R&D' there is an "apparent discrepancy" between the amount that government says it spends on R&D in industry and what industry says it receives from government. How does this situation arise and how can it be improved?

A. This is not relevant to DTI's completion of the Annual Review returns.

11. It has been suggested that the number of scientifically and technically qualified personnel employed on R&D is a better indicator of R&D effort than is the figure for R&D spending. Do you agree?

A. The numbers of personnel employed in R&D is a useful supplementary indicator of R&D effort, but cannot substitute for total R&D costs because pay represents only a part of R&D spend. Different types of research involve different overheads; in particular, some are much more capital intensive than others. In the case of very large capital facilities for R&D such as the European Transonic Wind Tunnel, it would be misleading to look only at the numbers of scientific and technically qualified personnel employed.

Memorandum by the Department of Transport

Q1. Do you use the Frascati definitions in making returns to the "Annual Review of Government Funded R&D"? If not what definitions do you use?

A1. We use the Frascati definitions.

Q2. Do you use the same definitions in your day-to-day operations, or is it necessary to use other definitions? If so how do these definitions differ from those used in the Annual Review?

A2. We use the same definitions.

Q3. Do you experience any difficulty in converting your figures for R&D spending into the format required for the Annual Review? Do you encounter any other problems in making returns to the Annual Review?

A3. The Annual Review format differs from the public expenditure and vote accounting information from which data are derived. Public Expenditure White Paper (PEWP), Supply Estimates and Appropriation Accounts include VAT but exclude notional superannuation, whereas the opposite is true of the Annual Review. The Annual Review timetable is tight. For plans for the estimate year Departments are asked to provide figures by the end of January before the Supply Estimates are finalised. The draft Supply Estimates from which we work can change before their formal publication in March. The PEWP is published at the end of January with figures for later years rounded. For these reasons, small discrepancies between the figures in the Annual Review and PEWP are sometimes unavoidable.

Q4. What explanatory notes or guidelines do you use in interpreting the Frascati definitions? Are they adequate for this purpose? What degree of subjectivity is involved in categorizing your R&D spending?

A4. We use the guidance notes provided by the DTI for completion of the relevant forms (77, 78 and 79 for 1988 review). They are helpful but any process which requires classification of a wide variety of R&D spending must necessarily be subjective in some cases.

Q5. Do the Frascati definitions provide a clear means of differentiating between:

- (a) basic and applied research;
- (b) research and development;
- (c) R&D and other related activities;

for the purposes, in each case, of:

- (i) compiling statistics of your department's R&D spending;
- (ii) compiling R&D statistics within a scientific and/or industrial sector;
- (iii) comparing R&D activity between different scientific and industrial sectors;
- (vi) making international comparisons of R&D activity?

A5. We use the Frascati definitions for the first purpose listed above, i.e. compiling statistics of the Department's R&D spending. We are not involved in the other three activities listed.

We do not fund basic research. It is sometimes difficult to distinguish between applied research and experimental development particularly where the application of research results must be through new or improved processes, systems or equipment. However, the difficulty is a marginal one: relatively small figures are involved in proportion to R&D overall.

There is potential difficulty in distinguishing between experimental development and technology transfer but again this is a marginal problem.

Q6. What are the specific inadequacies of the Frascati definitions, and how might they be amended? For example, the OECD is considering supplementing the "basic" and "applied" research categories with a "strategic" research category. The United States Department of Defense sub-divides "experimental development" into "exploratory", "advanced" and "engineering" development (Annex 2). Would there be any advantage in using these, or other, categories to classify your department's R&D spending?

A6. "Strategic applied research" already exists as a category in the Annual Review. Any advantages there might be in creating new categories are outweighed by the discontinuities created by changing definitions.

The greater the number of divisions, the greater the potential for differences of subjective judgements to be misunderstood as genuine shifts in category.

Q7. Would you give specific examples of the work funded by your department in 1986-87 which was recorded under each of the headings in Table 1.22 of the 1988 "Annual Review of Government Funded R&D", i.e.:

- (a) basic;
- (b) applied — strategic;
- (c) applied — specific;
- (d) experimental development.

A7. (a) None;

- (b) (1) Modelling studies of land use and transportation interaction;
- (2) Behavioural studies for road safety;
- (c) (1) Alkali aggregate reaction and its effect on the condition of bridges;
- (2) Studies of restrictions on routes for lorry traffic;
- (d) (1) High speed road condition monitor;
- (2) MOVA system for Traffic Control at isolated junctions.

Q8. Did any of the work funded by your department in 1986-87 fall outside the Frascati definition of R&D, but within the range of related activities which you have difficulty in distinguishing from R&D? If so would you provide specific examples of those activities with which you had difficulty. Was the spending on these activities included in Table 1.22? If not where was it reported?

A8. No.

Q9. The "Annual Review of Government Funded R&D" also classifies R&D spending according to "primary purpose". How does this classification differ from Frascati? What advantages, if any, does this classification have over Frascati?

A9. The primary purpose classification is more detailed than Frascati (nine categories not four). It also describes research as seen from the customers' viewpoint. It not only describes the research but indicates the justification for government funding e.g. support for policy formation, purchasing decisions or statutory duties.

Q10. In the "Annual Review of Government Funded R&D" there is an "apparent discrepancy" between the amount that government says it spends on R&D in industry and what industry says it receives from government. How does this situation arise and how can it be improved?

A10. We have no basis on which to judge whether or not this is true for Government funded R&D in general or transport in particular. We maintain analysis of research commissions by type of contractor from which Annual Review information is collated.

Q11. It has been suggested that the number of scientifically and technically qualified personnel employed on R&D is a better indicator of R&D effort than is the figure for R&D spending. Do you agree?

A11. It is useful indicator in that it is readily grasped and does not require adjustments for inflation. However, it does not reflect other costs such as the capital base from which they work, the degree of extra-mural research and development or indeed the experience and quality of the researchers themselves.

Memorandum by the Economic and Social Research Council

With reference to your letter of 26 May 1989, the ESRC's response to the issues described in the questionnaire is as follows:

1. ESRC does use the Frascati definitions in making returns to the 'Annual Review of Government Funded R&D'
2. ESRC does use the same definitions to categorise research proposals received under its Research Grants Scheme. The Council decided to do so some twelve months ago in order to facilitate the compilation of the annual return to the Cabinet Office.
3. The conversion of figures for R&D to the Annual Review format has in the past caused a number of problems. Prior to major change in our computer system and associated changes in the categories used, our own funding details were broken down by discipline and/or institution rather than whether the research was basic or applied. As indicated under 2, this problem has now been eliminated from classification of our responsive mode awards (Research Grants). Researchers are now required to define their own work by discipline and the Frascati basic applied and applied strategic criteria.
4. We do not provide formal explanatory notes or guidelines in interpreting the Frascati definitions to supplement those provided by the Statistical Office, but we do hold regular internal meetings between the divisional representatives compiling the data for the Annual Review to ensure

continuity. The issue of subjectivity is a real one and I think it has always been accepted that the categorisation of research is subjective.

5. The Frascati definitions are adequate for differentiating between the different research types and activities that we experience in the social sciences field.
6. In line with the modified definitions of Frascati given in Annex 3 of the 1988 Annual Review, ESRC has applied the additional category of "applied strategic" without difficulty. Such an addition is a useful clarification of the term "applied" and especially useful for the social science research which is often not directed at a single or specific group of eventual applications.
7. Examples of work funded in 1986-87 recorded in table 1-22 of the 1988 Annual Review.

Basic: Programme on Social Change and Economic Life

Applied strategic: Crime and the Criminal Justice System

Applied Specific: Educational research in classroom practices.

8. Work funded which fell outside the Frascati definitions included, The Teaching Company Scheme, described as technology transfer, and postgraduate masters courses. These items do *not* appear in table 1.22.
9. The advantage of the primary purpose codes are that they are clearly designed to categorise the research at a given moment in time, namely at the commissioning stage. It is never very clear when using Frascati whether you are categorising the objective, the methodology, the likely results or the whole package. This can cause difficulties, especially in the social sciences where the development of the methodological techniques may constitute basic research, but the results could have implications for specific policy. Primary purpose codes can therefore be seen as useful, complementary classifications to Frascati. The amendments to PP3 and PP2, introduced by the Cabinet Office in 1989, have made the interpretation for Research Councils much easier to apply.
10. As you will be aware, ESRC is required by its charter to fund research in institutions of higher education. The Council does not therefore fund industrial R&D and there is no reason for a discrepancy to arise.
11. As is often the case with indicators, the more there are the better the quality of the picture they portray. In assessing the level of research being supported, government should therefore look at the money allocated, the number of scientific and technical personnel *and* the research facilities (archives, computers, technical equipment) that it supports.

Yours sincerely

DAVID V. STAFFORD

Secretary

First Memorandum by the Fellowship of Engineering

The Fellowship of Engineering wishes to comment on the questions which the Sub-Committee plan to put to industry and agencies involved with R&D after Easter 1989. In addition, The Fellowship also wishes to respond to the questions themselves, following a survey of Fellows.

Being a collation the following paper cannot reflect the views of all contributing Fellows nor those of The Fellowship as a whole. It may, however, be regarded as representative.

The Proposed Questionnaire—General reaction and comments on the usefulness and precision of questions.

The Fellowship of Engineering fully supports the Committee's wish to establish the usage, validity and degree of understanding of definitions for R&D.

The draft letter which Sub-Committee II propose to use in a general survey after Easter 1989 introduces the subject in a clear and concise manner and covers the appropriate topics in the questions.

Evidence from Fellows who contributed to this response suggests that the Frascati definitions of R&D are not used to any significant extent in the UK. In many cases adaptations have been developed which are believed to be more appropriate to particular industries and institutions.

While most respondents from industrial background confirmed that the definition of R&D is not important to their organisations some Fellows from academic and other research institutions were concerned that simple figures for R&D spending, categorised according to Frascati or similar definitions, would not necessarily help policy makers to answer the question "How effective is R&D expenditure?"

However, The Fellowship believes that the proposed survey questions are sufficiently detailed to prompt a wide-ranging response which will satisfy the Committee's requirements.

Fellows who contributed to this response also offered replies to the questions themselves, together with related comments. These are given overleaf.

Response to Survey Questions

I. Do you use the Frascati definitions in identifying R & D and differentiating it from other activities? If not, what definitions do you use?

The Frascati definitions are generally acknowledged as the foundation upon which most Fellows build their own definitions of R & D. For that reason, and because of their usefulness in general discussion, the definitions command some respect.

However, The Fellowship has little evidence to suggest that the Frascati definitions in their original form are currently being used.

The Frascati definitions have some support from Fellows who believe that there is merit, for purposes of national and international comparison, in simplicity and freedom from confusing sub-division of categories. (Examples given are Strategic, Fundamental, Speculative, etc.). Those holding this view believe that the Frascati definitions, whatever their faults, offer the best route to an understanding by those in the policy making field and otherwise outside the immediate world of R & D.

Support for the above view is, however, relatively small among Fellows. A majority of contributors to this response took issue with the details and interpretation of the definitions and those with an industrial background put forward a number of modifications which suit their own purposes.

Three examples typify the variety of response:

The first, from a national utility company, employs definitions derived by Irvine and Martin (see Appendix A) from diverse sources, including Frascati. The most notable point in this case is the identification of 'strategic' research as an element of basic research.

The second example, from a national mature industry, provides the following definitions which suit the industry concerned:

Basic Research—"Experimental or theoretical work undertaken to acquire new knowledge and a basic understanding of scientific phenomena and observable facts whether or not there is a particular application or use in view".

Experimental Development—"Laboratory and pilot plant based experimental, theoretical and scientific work undertaken to improve the technical and economic performance of commercial operations".

Applied Research—"Research associated with the on-plant introduction of new materials, products or devices and the development of production scale processes, systems and services".

In these definitions Basic Research encompasses all basic research, contrary to Frascati.

Experimental Research means Laboratory and pilot plant based process and product research work. Applied Research entails the applications of technology.

The third example to be proposed is from a Fellow employed by a large manufacturer of many diverse products. His organisation defines Basic Research as gaining knowledge for its own sake. Strategic Research is 'the search for knowledge in an area perceived to be of strategic interest to the company'. Aimed Research is knowledge directed towards a device, process or material which has interest to the company. Development is defined as in the Frascati definition for Experimental Development—the difference being that the word 'experimental' is considered inapposite. In the foregoing definitions Strategic and Aimed Research constitute Applied Research.

It is evident from these few examples that important differences exist in currently-used definitions for R & D and it cannot be said that The Fellowship is able to put forward a unanimous view. It is however, notable, that strategic research is believed to be an important addition to the Frascati definitions.

Finally, a further example is provided by a Fellow whose company is heavily committed to both Civil and Defence R & D. His organisation employs three separate sources of R & D definitions:

1. Those used by the MoD.
2. Those used by the UK accountancy profession (SSAP 13).
3. Company definitions based on (1) and (2) but providing more detailed guidance.

All of these definitions have their origin in Frascati, but with certain important changes of wording. Strategic research is not recognised by (1) and (2).

II. Granted the Frascati definitions are the international standard, do they provide a consistent means of differentiating:

- (a) between R & D and other activities;
- (b) between different kinds of research, and between research and development for the purposes in both cases, of:
 - (i) compiling statistics of R & D activity within an industrial and/or scientific sector;
 - (ii) comparing R & D activity between industrial and/or scientific sectors;
 - (iii) comparing R & D in the civil and defence sectors in the United Kingdom;
 - (iv) international comparisons of R & D activity;
 - (v) compiling company accounts.

Generally, Fellows do not believe that the Frascati definitions allow the above analyses to be made reliably.

For the purposes defined the greatest problem is generally held to concern Development, invariably the most expensive and difficult part of the R & D chain. In this connection several Fellows reject the use of the word 'experimental' as inappropriate to industrial activity. It has also been pointed out that there is a major difficulty in defining where (experimental) development ends and the first stages of the ensuing new production begins. This latter uncertainty can greatly affect the D stage of an R & D programme.

In consequence, The Fellowship's response to the various questions may be summarised as follows:

- (a) They are satisfactory for differentiating between basic and applied research on the one hand and other activities (although a caveat might be registered concerning strategic research), but are not satisfactory for "Development".
- (b) As (a).
 - (i) Given the problem outlined with the definition 'Development' statistics compiled on the Frascati basis can therefore be misleading.
 - (ii) As for (i).
 - (iii) The definitions are satisfactory when comparing like with like but still would not cover the whole picture. There is a difference between the 'development' objectives of Civil work compared with the specific needs of Defence, where the cost effective and competitive edges are not of such importance as effectiveness for the military aim.
 - (iv) As for (i).
 - (v) As for (i).

The Fellowship strongly favours the disclosure of information on R&D expenditure in company accounts. However, meaningful comparisons between different organisations depend not only on clear definitions of the R&D activity but also of the type of expenditure being considered (e.g. revenue, capital, gross or net of income etc.) and of the level of business activity to which it relates (e.g. company turnover, value added etc.) which are not always unambiguous.

III. What, therefore, are the specific inadequacies of the Frascati definitions and how might they be amended?

The Frascati definitions have a number of inadequacies but Fellows contributing to this response tend to offer in their choice of the 'greatest' weakness. In consequence, as all such contributions have value and importance (not least within Fellows' own organisations) the following list details concerns which have been registered, in no particular order of priority:—

An important omission in the Frascati definitions is the concept of 'strategic research'.

Large industrial organisations often include 'Technical Service' (or 'Engineering') in their budgets for R&D. These terms cover the use of facilities and expertise associated with R&D to support the transfer of technology and provide short-term technical assistance, trouble shooting etc., to the operating divisions of the company. Whilst such companies acknowledge that such activity strictly falls outside the definitions of R&D it can and often does consume a considerable portion of a declared R&D budget. The Frascati definitions do not deter such an inclusion. A statement to the effect that Frascati-type R&D activity is considered to cease at the first commercial sale might help to clarify matters.

There would be benefit in linking any improved definitions to those used in Accounting Standards. One Fellow has drawn attention to practice in the United States, where disclosure is required in a Corporation's 10K report and the Financial Accounting Standards Board have a standard with all relevant definitions. (The Fellowship has not in the short time available been able to pursue this further but the Committee may choose to do so).

There is a need to refine the definition 'Experimental Development' so that the cut-off points between research, design and development and production are clearly established. The problem in practice is that in bringing a product or process to a successful competitive conclusion, there is a constant interplay between basic and applied research and 'experimental development'. Many Fellows reject the word 'experimental' as inappropriate in industrial use.

Some recognition might usefully be given to innovation in relation to experimental development.

Finally, one Fellow suggests that the Frascati definitions are bound to be unsatisfactory because they attempt to attach labels to the general nature of research, rather than to the nature of the output of the activity. This leads, however, to a new area for research beyond the timescale of the Committee's current concerns.

Nature of R & D		Main performer(s)
<p>Basic Research:</p> <p>Original investigation with the primary aim of developing more complete knowledge or understanding of the subject(s) under study.</p>	<p>Pure of curiosity-orientated research:^a</p> <p>Basic research carried out without working for long-term economic or social benefits other than the advancement of knowledge, and no positive efforts being made to apply the results to practical problems; or to transfer the results to sectors responsible for its application.</p>	<p>Normally (together with teaching) the main function of the academic university-based research system.</p>
	<p>Strategic research:</p> <p>Basic research carried out with the expectation that it will produce a broad base of knowledge likely to form the background to the solution of recognised current or future practical problems.</p>	
<p>Applied or tactical research:^b</p> <p>Original investigation undertaken in order to acquire new knowledge, and directed primarily towards specific practical aims or objectives such as determining possible uses for findings of basic research or solving already recognised problems.</p>		<p>Mainly carried out by industry and laboratories of mission-oriented government agencies, although also undertaken (under contract or as part of targeted government research programmes) within the academic research system.</p>
<p>Experimental development:</p> <p>Systematic work drawing on existing knowledge gained from research and/or practical experience that is directed towards producing new or improved materials, products, devices, services, systems or methods, including design and development of prototypes and processes.</p>		<p>Overwhelmingly carried out in industry (where it typically accounts for 80-90 per cent of company R & D budgets) and in mission-oriented government agencies (often where the state is also the customer for the final envisaged product, such as advanced military hardware).</p>

Source: Derived from National Science Board (1963, p.237), OECD (1981, pp. 25-36) and Ronayne (1984, p.35).

^a This is sometimes referred to as 'fundamental' research, although the term can also refer to certain longer-term elements of strategic research.

^b This is also sometimes referred to as 'mission-oriented' research, particularly in US government agencies, although such work often incorporates shorter-term elements of strategic research.

From: Foresight in Science. J. Irvine and B. R. Martin, Pinter, 1984.

Second Memorandum by the Fellowship of Engineering

I am pleased to enclose The Fellowship's response to your letter of 19 May, 1989. You may recall that Sub-Committee II posed new questions following our first response in March 1989.

We found on this occasion that considerably fewer Fellows were able to contribute to our response. In consequence, the Sub-Committee may be disappointed to find that its detailed questions have not received equally comprehensive answers. Most Fellows could add little to their earlier remarks; this in itself may be of interest to the Sub-Committee.

A common theme running through the replies which we have received is that the establishment of precise definitions is only part of the problem which faces the Sub-Committee. There is a widespread belief, notably among Fellows familiar with small and medium sized companies, that such organisations do not normally have the knowledge or the staff to generate reliable Frascati-type R&D figures. Training in the interpretation of definitions appears to be an important factor.

Our experience in seeking contributions to The Fellowship's present response suggests that before any definitive conclusion could be drawn a research investigator ought to examine this area and visit companies to establish their interpretation of whatever definitions are used.

Yours sincerely,

G. A. Atkinson

Head of Secretariat

The Fellowship of Engineering wishes to comment on follow-up questions received from the Sub-Committee in May 1989.

Being a collation the following paper cannot reflect the views of all contributing Fellows nor those of The Fellowship as a whole. It may, however be regarded as representative.

The Sub-Committee should note that the response by Fellows to the latest questionnaire was about one third of that received for the first draft questionnaire in March 1989.

RESPONSE TO SURVEY QUESTIONS

The following comments address the questions posed in the Sub-Committee's questionnaire of 19 May 1989. Questions are answered in the order in which they were given.

1. Definitions of R&D in use

In our first response of March 1989 we recorded the definitions which are in use by four major British companies. Even though two of these companies are in the same industrial sector we have to report that in common with the other companies, their definitions differ and tend to be tailored to suit individual company needs.

We cannot add materially to the definitions given in our earlier response. However, one Fellow with knowledge of the telecoms/electronics industry, reports that he is not aware of any organisations using the Frascati definitions as such. What seems to be more common in his experience is a split along the lines:

- Corporate funded long range R&D
- Company or operating group sponsored R and/or D
- Product Development.

The Fellowship has also received evidence suggesting that in smaller companies, even where research is the principal activity, the Frascati definitions are virtually unknown.

The Fellowship's general findings from its latest survey are, in consequence, that most large companies use and apply definitions of R&D whilst many smaller companies do not. Where definitions are in use their relationship to Frascati is often tenuous.

2. Returns to the DTI Industrial Survey

Only one of the respondents to the latest Fellowship survey (from a major UK company) has suggested that he has no difficulty in completing the DTI survey.

Other respondents have pointedly offered no comment. It has also been suggested that such statistics are often collected by the accounting function which is in no position to review them critically.

3. Guidelines used in interpreting Frascati definitions

Once again, practice was found to vary widely, as between large and small companies.

The concept of 'appreciable element of novelty' has been described as being open to subjective definition. Accountants, industrial and academic researchers and marketing people tend to give differing interpretations of the same phrase.

4. *The usefulness of existing UK R&D Statistics*

One major British company stood out from other respondents in saying that "its statistics are reliable and based on audited accounts".

Other respondents were much less confident, to the extent of suggesting that there is no way of knowing the degree of reliability of statistics.

5. *Factors which limit the accuracy of R&D statistics*

Opinions were divided among Fellows concerning the significance of small firms. One view holds that small firms do a lot of R&D in the early years and then either fail or are taken over by big firms. Another belief is that omitting small company data is unlikely to influence Basic or Applied categories very much but may affect the Experimental development figures. We would add that only respondents from major firms acknowledged familiarity with the DTI survey of industrial R&D.

6. *The ability of the Frascati definitions to differentiate between various activities and for various purposes*

The Fellowship cannot add significantly to the comments made in answer to a similar question in its first response (March 1989).

Fellows who responded on this occasion were, perhaps, less inclined than the earlier group to offer support for the Frascati definitions. A common remark was that the definitions are too open to modulation by the assessor. The Marketing Manager's "long-range basic research" is the University physicist's "short-term product development".

Support for the definitions was received from only one source—a major UK mature manufacturer. Nevertheless, even this company recognises that different organisations use their own definitions and that the effects of this are likely to be most marked in the case of international comparisons.

7. *Improving existing definitions of R&D*

Fellows expressed considerable support for the US Department of Defense definitions, modified to suit civil research. Additionally, further supportive reference was made to American Financial Accounting Standard No. 2. ("Accounting for Research and Development Costs").

Fellows particularly liked the US DoD method of accounting for Development, citing as a typical reason the improved link between R&D, the product and the time scale.

It has also been pointed out that Basic Research is rarely carried out by industry, except in the case of some multi-national companies.

Fellows also emphasised that even if the US DoD definitions are used there will still be a need for personnel trained in their application.

8. *Examples of Frascati R&D and related activities*

Fellows declined to give detailed answers to this question. However, the point was made several times that UK firms in several different sectors do not normally engage in Basic Research.

One Fellow, concerned with loosely linked short and long term University programmes in semiconductors, Optoelectronics and optical systems suggested that these might prove a challenge to any assessor attempting to judge the various constituents against Frascati definitions.

Another respondent, from a major process manufacturer of mature products reported difficulty, in the case of his company, in separating Frascati applied research from experimental development. In this case problems arose not from a change in the type of work but rather in its scale.

An advocate of the US Department of Defense definitions commented that these were much more appropriate for acknowledging the expensive and time-consuming activities associated with the need to get an innovation into the market place. In his view, and as noted in our first response, the Frascati definition of experimental development is misleading and vague.

The Fellowship concludes that detailed case studies must be commissioned if the Sub-Committee is to have the information which it seeks.

9. *The discrepancy between expenditure on R&D by Government and the sum received by industry*

One Fellow reported that in his experience Industry has to spend much more on collaborative R&D with Government than would be indicated by the Government figures. In apparently equally funded collaborations the industrial partner has to cover many overheads, over-runs and unforeseen items which are not directly attributable to the core funding.

A further suggestion related to Government expenditure on the Research Associations. How does this enter the calculations of Government expenditure on R&D in industry?

10. *The use of qualified people working in R&D as a better indicator of effort than total spend*

It is generally agreed within The Fellowship that it would be useful to have figures for the numbers of personnel engaged wholly and only in R&D, as an addition to, but not in place of, the total expenditure.

It has been pointed out that “qualified” means different things in different countries. Furthermore it has been reported that the DTI return quotes both figures at present.

To demonstrate that problems could occur with the proposed figures for personnel one Fellow cited a company with 6000 staff and no graduates which nevertheless has a reputation for being very innovative in the field of textile machinery. Clearly this is an extreme case but it does highlight the need for care in the interpretation of figures.

Memorandum by the Health and Safety Commission

GENERAL COMMENTS

We are satisfied that we understand the Frascati definitions perfectly well. In principle, these definitions do form a satisfactory basis for comparing R&D effort. However, we have no information on whether they are applied differently in practice by different countries, industries or organisations.

An important point to bear in mind in this connection is that the Frascati definitions do not determine the formats of the R&D programmes that we receive from research organisations, in this country and overseas, with which we have overlapping interests. It is therefore not possible to arrive at a conclusion as to how these organisations use the Frascati system. However, this does not matter from our point of view. In addressing the programmes, we are primarily concerned with their content and the extent to which a particular project might be of interest to us, rather than any classification considerations. Naturally, we are interested in broadly how much a particular country is spending on occupational health and safety research, but only in terms of overall effort and not any sub-division of this.

There is one further general point that we would like to make. In its mid-term review of the Framework Programme, the European Commission is using such terms as “basic”, “applied”, “focused fundamental” and “pre-competitive” research. Any sensible discussions within the Community need clear and commonly-agreed definitions of these terms. The Frascati definitions do not help here.

ANSWERS TO SPECIFIC QUESTIONS

1. Yes, we do use the Frascati definitions in making returns to the Annual Review of Government-funded R&D.

2. We use the Frascati definition of research to divide our overall R&D effort from our other science and technology activities, and it is this Frascati figure that we quote, both in publications and in HSE-internal documents, whenever we need to provide an indication of our R&D effort. Further breakdown of this into basic, applied (strategic and specific) and experimental development is carried out purely for the purposes of the Annual Review of R&D. We make no additional use of this information.

Instead, for planning purposes, the R&D is divided into six broad categories, reflecting the hazard to occupational health and safety. Thus, one such category relates to fire and explosion hazards. This broad classification is used by HSE’s Research Committee to judge whether the balance of R&D resources is in line with HSE’s overall priorities and we also use the classification for our own management purposes. A different classification in terms of Frascati would not be of value in either case.

Another point is that our R&D spending (currently running at about £5.3 million per annum) is very small compared with other Government R&D spending, and there is a limit to how much it is worth sub-dividing this.

3. No in each case.

4. For interpreting the Frascati definitions, we simply use the explanatory notes that are part of the Annual Review of R&D forms each year. We find these notes quite adequate for the purpose. Inevitably, some subjectivity is involved in the categorisation process, but we do not consider this to be excessive if the definitions are applied carefully.

5. The Frascati definitions provide a clear means of differentiating, for the purposes of compiling statistics of our R&D spending. However, we do not carry out any of the other activities outlined in items (ii), (iii) and (iv).

6. As mentioned in question 2, we do not use the Frascati sub-divisions for our own purposes. We are therefore not in a position to form a view on whether there are any specific inadequacies in the definitions. By the same token, we would not benefit from any further sub-division of experimental development, or similar changes in categorisation.

7. (a) *Basic*—none.

(b) *Applied (strategic)*

—Filtration characteristics of electrostatic filter materials.

- Markers of early change in chemical carcinogenesis.
- Dispersion characteristics of gases heavier than air.

(c) *Applied (specific)*

- Fire and explosion hazards associated with the industrial use of LPG.
- Fracture of toughness of a specific steel at high rates of loading.
- Development of methods for measuring airborne concentrations of specific toxic substances.
- Evaluation of health hazards posed by micro-organisms in oil emulsions.

(d) *Experimental development*

- Development of a dust monitor that gives instantaneous readings.
- Development of a triggered water barrier for suppressing dust explosions.
- Experimental study of non-sparking materials.

8. We are quite happy with our split between R&D and related activities. We have refined this over a period of years, in collaboration with the Cabinet Office, in order to provide figures for the Annual Review of R&D.

9. The Frascati classification is based on the type of research, whereas the primary purpose classification is concerned with the purposes of the research. As such, the primary purpose classification is closer to the philosophy of the hazard area classification that we adopt for our own management purposes (see question 2). Our hazard area classification looks at the purposes of the research, though from a somewhat different stand-point. From our point of view, the purposes and objectives of the research are more important than the type.

10. We are not in a position to offer any explanation or remedy for the apparent discrepancy. This is more a matter for DTI.

11. We would not necessarily agree that the number of scientifically and technically qualified personnel is significantly better than the spending figure as an indicator of R&D effort. There are various points to consider. For example:

- (a) The relationship between manpower and overall expenditure is partly dependent on the nature of the research. Thus, some classes of work require expensive capital facilities that will mainly be used by one person on one project, whereas some require predominantly manpower with only modest facilities. The manpower figure would neglect the substantial capital costs, but equally the spending figure might be thought to exaggerate the figure if, for example, an expensive piece of equipment was bought but there were insufficient staff to run it.
- (b) The ratio of qualified personnel to administrative and industrial support staff is also important. A research establishment with a low ratio would register a relatively low research output for a relatively high cost. However any such indicator needs careful interpretation; greater use of administrative and unqualified staff can promote research by releasing scientists from more general and management duties. Manpower is perhaps the better indicator from this point of view.

Memorandum by the Home Office

Question 1: Yes

Question 2: This varies in different parts of the Home Office. In one important area similar definitions are used, while in other areas quite different categorisations are used—these refer mainly to the identity of the customer.

Question 3: The difficulties experienced relate to the nature of the day-to-day categories; where they match reasonably closely then there are no major problems in converting our figures. For the textual contribution, the headings supplied for the 1989 Review did not match particularly well those used in some of our departments but this posed no difficulties.

Question 4: Other than those supplied by the DTI, no explanatory notes or guidelines are used; very little subjectivity is involved in categorising R&D.

Question 5(a)(i): Yes

Question 5(b)(i): Yes

Question 5(c)(i): Yes

Question 5(a)(ii)(iii)(iv), 5(b)(ii)(iii)(iv), 5(c)(ii)(iii)(iv): N/A

Question 6: By and large, the existing headings suit the work as well as any others are likely to, and in any case are used only for the purpose of the Annual Review. The DTI enquiry point is not always effective in dealing with questions. The research ranges from highly focussed specified projects to those which have wider applications and policy relevance. It is difficult to see what the difference between “strategic” and “applied” research would be in relation to much of our R&D. The US Department of Defence categories are not obviously applicable to our social research.

Question 7: Most expenditure was categorised as applied-specific; smaller quantities were categorised as applied-strategic or experimental development.

Examples are:—

- b—DNA analysis;
- c—objectives of traffic policing;
- analysis of paint by thin section;
- development of miniature speech transmitters;
- studies of causes of death in firefighters;
- d—computer software for schools on crime; and
- enzyme-linked immunosorbant assay.

Question 8: Some resources have been used for work probably falling outside the strict Frascati definition of R&D—for example, policy advice. However, the spending has been included in Table 1.22.

Question 9: Frascati definitions described the type of R&D while primary purpose categories define the objective of the work. The primary purpose classifications system offers no advantage over the Frascati classifications for the Home Office.

Question 10: We cannot comment on this discrepancy other than to state the obvious: that the definitions are somewhat open to interpretation and the interpretations of government and industry may differ.

Question 11: If the basis for indicating effort were to change then we believe that a system employing both speed and manpower would be preferable.

Memorandum by the Institute of Chartered Accountants in England and Wales

Introduction

1. The preamble to the Select Committee's Questionnaire notes that figures for research and development (R&D) spending are increasingly used as indicators of industrial and national investment in innovation and form the basis for science policy making. The object of the Questionnaire is therefore to assist the Sub-Committee of the Select Committee in determining the accuracy of UK figures for R&D spending and the reliability of international comparisons of R&D spending.

2. It is also noted in the Questionnaire that "The Management of Scientific and Technical Activities: the Frascati Manual 1980" published by the Organisation for Economic Cooperation and Development in 1981 is at present being revised and that consequently another objective of the current enquiry is to contribute to OECD's revision of the Frascati definitions.

3. In the following paragraphs of this memorandum we set out first our general observations and secondly seek to answer the specific questions posed.

General observations

4. Statement of Standard Accounting Practice No. 13 "Accounting for Research and Development" was originally issued in December 1977. At that time it represented a significant step forward in the recognition in accounts of expenditure on R&D activities. SSAP13 has since been revised and the revised edition dated January 1989 is effective in respect of financial statements relating to accounting periods beginning on or after 1 January 1989.

5. The revised edition of SSAP13 was the product of wide consultation not only with preparers and users of accounts but also with the Department of Trade and Industry. SSAP13 takes for its model the Frascati definitions in so far as it identifies the categories of pure (basic) research; applied research; and development although as will be seen from paragraph 21 of the SSAP it does not follow the detail precisely. The object of the SSAP13 definitions is to seek to make the detail of the three categories more susceptible to analysis for the purposes of the preparation of accounts.

6. As we see it, the Frascati definitions suffer from allowing an interpretation which is too wide. For example, the phrase "to acquire new knowledge of the underlying foundation of phenomena and observable facts" is in our view too all-embracing and could lead to difficulties in assessing comparative performance.

7. While we believe that the definitions in SSAP13 represent an improvement on the Frascati definitions, we stress that insufficient experience of the operation of the SSAP has yet been obtained to draw firm conclusions as to their effectiveness as an appropriate yardstick. We consider it important, however, that the present position should remain undisturbed for the time being to allow experience of its operation in practice to be obtained.

Use of the Frascati definitions pre SSAP13 (Question 1)

8. We are not aware of the extent to which the Frascati definitions were used before the revision of SSAP13. It is the publication of the revised version which has highlighted the importance of R&D issues for the majority of UK companies. We expect that any variability which might have existed in the use and understanding of R&D definitions will be reduced as a result of the publication of SSAP13.

Day to day operations and SSAP13 (Question 2)

9. It is possible that for their own internal purposes some companies may choose to adopt definitions of R&D which differ in certain respects from those in SSAP13. However, we believe that the SSAP, having been the subject of consultation reflects general practice.

Interpretation of definitions (Question 3)

10. For the purpose of compiling company accounts, Part I of SSAP13 contains explanatory notes for the interpretation of the definition of R&D expenditure contained in Part II. The explanatory notes include in paragraphs 6 and 7 examples of activities falling within the outside R&D. It is perhaps too early to say whether they are adequate. We accept that there is likely always to be an element of subjectivity involved in identifying R&D costs but believe that this is considerably reduced by the provision of examples.

Differentiation between categories (Question 4)

11. We have already expressed the view in this memorandum that the Frascati definitions are too widely drawn. The problem remains, however, that any definition is unlikely to be exhaustive without being imprecise. It follows that in seeking to differentiate between categories of R&D similar problems will arise. We think that in practice examples will always need to be provided as a supplement.

Specific inadequacies of the Frascati definitions (Question 5)

12. We consider that the Frascati definitions are difficult to apply in areas which are not scientific and technological. The difficulty stems in the main from the fact that if the definitions were any wider the scope for uncertainty would be correspondingly increased. This is particularly the case when dealing with matters in the sphere of the social sciences which are perhaps within the contemplation of the Frascati definitions but which do not feature in SSAP13.

13. We do not think that the application of the Frascati definitions themselves gives rise to problems with the treatment of R&D in relation, for example, to government contract work. Any problems here chiefly arise from the necessity to ensure that for accounting purposes the R&D element is identified while at the same time double counting is avoided. This we think is achieved as SSAP13 requires a company to account for its own R&D expenditure. In the case of a government contract, the government is the entity commissioning the R&D which will not appear in the company's accounts as such.

Number of R&D personnel as an indicator (Question 6)

14. We are not convinced that a better indicator of a company's commitment to R&D would be the number of scientifically and technically qualified personnel employed rather than money spent on R&D. The number of R&D personnel employed can frequently bear little or no relation to a company's R&D commitment. This is especially the case where the R&D effort necessitates the use by a few specialists of expensive machinery or apparatus. Particulars of R&D manpower in the UK could be sought direct from companies as part of a statistical survey if that were considered desirable. We do not think that it would be helpful to require such details to be disclosed in companies' financial statements.

GCW/TP

14-6-1

5.7.89

Memorandum by the Institute of Chartered Accountants of Scotland

Thank you for your letter of 19 May 1989 inviting comments on the questionnaire prepared by the Select Committee on Science and Technology. The questionnaire was circulated for comment to members of this Institute's technical committees and a response has been compiled from the answers received.

We would comment on the questions as follows:

Question 1

It would appear that, prior to the revision of SSAP13, the use and understanding of the Frascati definitions of R&D varied widely among preparers of company accounts. The reason for this may have been that, before SSAP13 (revised) was issued, there was no requirement to disclose the R&D spend and few companies did so.

The revision to SSAP13 is likely to increase the comparability, as between one year and another, of the R&D spend as reported by individual enterprises. However it is unlikely to improve comparability *between* enterprises. This is because of the complete absence in SSAP13 of any guidance as to how to determine what expenditure should be allocated to an identified activity.

Question 2

There is a wide divergence of views as to whether the definitions of R&D used by companies in their day to day operations differ from those used in SSAP13 (revised). However it is possible that, as SSAP13 (revised) only took effect for accounting periods beginning on or after 1 January 1989, there will be an increasing tendency for enterprises to adopt the SSAP13 (revised) definitions in their day to day operations. Any enterprises not doing so presumably will ensure that their accounting records are adequate for converting from one set of definitions to another.

Question 3

We are not aware of any explanatory notes or guidance, other than that of SSAP13 (revised), being used to interpret definitions of R&D spending for the purpose of compiling company accounts.

Our response to Question 1 notes our view that the guidance in SSAP13 (revised) is unlikely to improve comparability between enterprises.

At the margin, the question of identification of R&D costs must always be a matter of considerable subjectivity.

Question 4

- (a) Yes
- (b) Yes
- (c) Yes

but all are subject to our comment at Question 3 above concerning subjectivity at the margin.

We note that SSAP13 (revised) differentiates between basic research, applied research and development whereas the third category in the Frascati manual is "experimental development". The word "experimental" seems to imply a considerable degree of doubt as to whether a product can be developed and, therefore, doubt as to whether or not capitalisation is justified if specific conditions are met. We prefer the term used in SSAP13 (revised).

Question 5

We agree that the main inadequacy of the Frascati definitions is the heavy bias towards scientific, laboratory-based endeavour. We believe that, as R&D expenditure in areas such as developing new services/markets is more commonly met, consideration should be given to dealing specifically with such expenditure.

We are unclear regarding (b) in this question as paragraph 21 of SSAP13 (revised) specifically excludes such work from this context. We also presume that "accounted for" in line 3 is intended to be "disclosed".

Question 6

No. Disclosing the number of scientifically and technically qualified personnel employed would not be a better indicator of the enterprise's commitment to R&D. Our reasons for this belief are as follows:

- (1) qualified personnel may not be employed on R&D work;
- (2) the enterprise may have significant numbers of research and development assistants who are not qualified;
- (3) large parcels of research and development work may be contracted out to specialist agencies, universities etc., and
- (4) much R&D expenditure involves a large initial injection of capital, regardless of the number of qualified personnel involved.

I hope these answers are of help to Sub-Committee II in its deliberations in the Autumn.

Yours sincerely

AILEEN E BEATTIE

Director, Accounting and Auditing

Memorandum by the Medical Research Council

1. *Do you use the Frascati definitions in making returns to the 'Annual Review of Government Funded R & D'? If not what definitions do you use?*

We use the Frascati definitions.

2. *Do you use the same definitions in your day-to-day operations, or is it necessary to use other definitions? If so how do these definitions differ from those used in the Annual Review?*

We do not use the Frascati definitions for the purposes of our day-to-day operations. We distinguish between clinical and non-clinical research.

3. *Do you experience any difficulty in converting your figures for R & D spending into the format required for the Annual Review? Do you encounter any other problems in making returns to the Annual Review?*

We have no difficulty in providing overall figures for the purposes of the Annual Review. We have some difficulty in providing a breakdown for different scientific programmes, especially as the guidelines change from year to year. However we hope that the approach adopted for the 1989 Review — involving a breakdown into four major programmes — will prove satisfactory, and that it can be continued. Otherwise our problems in making returns for the Annual Review relate to the areas covered under 4 and 5 below.

4. *What explanatory notes or guidelines do you use in interpreting the Frascati definitions? Are they adequate for this purpose? What degree of subjectivity is involved in categorizing your R & D spending?*

We use the Cabinet Office guidelines in interpreting the Frascati definitions. We have no difficulty in distinguishing between Frascati and non-Frascati R & D, but in presenting information on MRC support we have problems in distinguishing between basic, strategic applied and specific applied research.

5. *Do the Frascati definitions provide a clear means of differentiating between: (a) basic and applied research; (b) research and development; (c) R & D and other related activities;*

As far as the MRC is concerned, the Frascati definitions do not provide a clear means of differentiating between basic and applied research. The Council supports a substantial amount of research which spans the Frascati "basic" and "applied" categories: work which cannot be said to be undertaken "without any particular application or use in view" but which on the other hand is not "directed primarily towards a specific practical aim or objective."

The need to distinguish between research and development is not an issue for the Council. The only activities funded by the Council which fall outside the Frascati definition relate to awards to medical and dental students who wish to intercalate an honours degree in science; there are no difficulties in identifying separately this small element of the Council's expenditure. With regard to technology transfer, the Council sees its involvement in this area as an important part of research and does regard it as a separate activity. We also regard restructuring as a normal part of research activity.

6. *What are the specific inadequacies of the Frascati definitions, and how might they be amended?*

From the MRC's viewpoint a classification system which distinguished two categories of research: specific applied (which we could equate with clinical and epidemiological research) and a category which combined basic and strategic applied (which we could equate with all other MRC research) would be more in accord with the way we classify our research programmes for our own internal purposes. Whether or not this would be satisfactory for the Annual Review would, of course, depend upon the nature of the policy decisions which are informed by the data provided.

Because the Council is not directly involved in development work we have not needed to address any question of sub-divisions along the lines of those used by the US Department of Defense.

7. *Examples of the work funded recorded under basic, strategic applied, specific applied and experimental development categories*

Specific applied—clinical and epidemiological research.

Strategic applied—other work in MRC establishments.

Basic—non-clinical grants to universities.

8. *Did any of the work funded in 1986-87 fall outside the Frascati definition of R&D, but within the range of related activities which you have difficulty in distinguishing from R&D?*

The only work that fell outside the definition related to intercalated awards, and it did not cause us difficulties to produce separate figures for these. The spending on these awards was not included in Table 1.22.

9. *The 'Annual Review of Government Funded R&D' also classifies R&D spending according to 'primary purpose'. How does this classification differ from Frascati? What advantages, if any, does this classification have over Frascati?*

We equate primary purpose 1 (PP1) with basic research, and we divide work in the strategic and specific applied categories between primary purposes 2 and 3 (health services research falling under PP2, the rest under PP3 on the improvement of technology). These categories seem more appropriate for the work of Departments rather than that of the Research Councils.

10.—

11. *It has been suggested that the number of scientifically and technically qualified personnel employed on R & D is a better indicator of R&D effort than is the figure for R&D spending. Do you agree?*

No. Capital investment between different areas of science differs so much as to make this approach implausible. To illustrate this point one might juxtapose the areas of nuclear physics and epidemiology.

Memorandum by the Ministry of Agriculture, Fisheries and Food

Q1. Yes. This is required by Annual Review procedures.

Q2. For certain areas of MAFF's work (for example, fish stock management and protection of the aquatic environment) records are maintained for Departmental management purposes on a wider basis than R&D, to include eg routine monitoring and data collection. MAFF does not use different definitions of R&D as such.

Q3. It is necessary to apportion the cost of multi-functional staff and facilities. For example, ADAS staff may be engaged both in R&D and in provision of advisory services. Similarly, a fisheries research vessel may be used on the one cruise as a platform for a variety of experiments and data collection; the same data may in fact be used both for research and other purposes. These factors complicate the attribution of expenditure to particular activities.

In addition, research projects often straddle more than one category. For example, a MAFF project on development of novel methods of pest control comprises mainly work at "applied-strategic" level on laboratory investigation of natural or synthetic compounds that will disrupt production on insects' natural juvenile hormone; but it includes also work at "applied-specific" level on the synthesis of C-13 labelled insect juvenile hormone III, and work at experimental development level on large scale practical evaluation under controlled conditions of juvenile hormone analogues. Similarly, laboratory investigation of Near-infrared Reflectance spectroscopy for detection of insects and mites in stored products (applied-specific) leads into evaluation under practical field conditions to a point where commercial funding becomes a possibility (experimental development).

These factors could be expected to remain problems under any alternative definitions of R&D or format of Annual Review. It needs also to be recognised (although this is not necessarily a source of difficulty) that R&D cost records may be maintained on different bases, e.g. cash or full economic cost. The Annual Review figures are required to be on an intermediate basis, which provides for e.g. implied superannuation liability for staff currently employed on R&D, but treats capital as in-year expenditure rather than on a depreciation basis.

Q4. MAFF follows explanatory notes which are issued by DTI Statistics Division, in association with the Science and Technology Assessment Office (Cabinet Office), in order to ensure uniformity of interpretation by Departments. MAFF regard them as adequate for the purpose. Some degree of subjectivity is inevitable in applying definitions to particular cases.

Q5(i) Yes, as regards (a) and (b). Guidance on the distinction between R&D and other related activities is contained primarily in the DTI notes.

Q6. The Annual Review already subdivides applied research into "strategic" and "specific" categories. MAFF has no further amendments to suggest. The Adoption of different definitions by particular Departments, as by the US Department of Defense, would be potentially confusing and undesirable.

Q7(a) The only basic research funded by MAFF is the work of the Royal Botanical Gardens (plant taxonomy, anatomy, biochemistry and cytology) which is financed out of MAFF's grant-in-aid.

Q7(b)-(c) Some examples have been given in the reply to Question 3 above. In addition:—

Applied strategic

General and molecular control of the efficiency of muscle growth in cattle and sheep, and of the reproduction in pigs.

Studies on the pathogenesis, immunology, aetiology and epidemiology of respiratory and enteric diseases of livestock.

Techniques for monitoring movement of nitrate in the soil.

Development of methods of chemical analysis e.g. for residues of pesticides in soil.

Investigations into the factors, including chemical preservatives, affecting the growth of bacteria in fishery products.

Applied-specific

- Nutritional utilisation for growth and lactation in cattle.
- Effects on agrochemical use and husbandry practice on non-target organisms.
- Effect on agricultural practices on water quality.
- Determination of fish protein in prepared products.
- Hydrocarbon pollution in the marine environment.

Experimental Development

- Crop variety trials.
- Fertiliser responses in specific cropping situations. Sward/animal interrelationship in ruminants.
- Improvements in the efficiency of fish smoking.
- Design and development of a multipass freezer for fish.
- NB* Some of the above work would now be considered appropriate for industry funding.

Q8. Routine data collection is expressly excluded from R&D by the DTI notes referred to in reply to Question 4. For example, monitoring of the levels of certain contaminants in food is not R&D. On the other hand, similar surveillance operations for the purpose of "one off" investigation of a situation not previously studied, or the effect of some change in food processing or dietary habits, would be regarded as R&D. Again, routine analysis of foodstuffs to check compliance with specifications or standards would not be R&D, but the same analytical determinations as part of the assessment of an experimental batch would be. The distinction between R&D and non-R&D may be determined by the objective rather than the nature of the task. The application to particular cases is kept under review.

All MAFF expenditure is reported in the Appropriation Accounts; only that considered to fall within the Frascati definitions of R&D is included in Table 1.22 of the Annual Review. Estimated costs of technology transfer are given in the MAFF text of the Annual review (at page 57).

Q9. The classification by primary purpose serves a different purpose from the Frascati classification by type of R&D. The only correlation between the two is that "basic research" should equate to the sum of "PP1—advancement of science" and "PP6—support for the humanities". Frascati answers the question "What?" The primary purpose classification answers the question "Why?"—a necessary question in consideration of policy and priorities for Exchequer funding.

Q10. Primarily a matter for DTI. MAFF is not qualified to comment.

Q11. There is value both in the number of qualified personnel engaged on R&D and in spending figures.

General comment

Q12. The questionnaire concentrates heavily on Government funding as reported in the Annual Review. For an assessment of total UK activity it is necessary to include funding by the private sector and other sources, eg overseas. MAFF is not able to advise the Select Committee on this aspect.

Memorandum by the Natural Environment Research Council

1. INTRODUCTION

1.1 The Natural Environment Research Council (NERC) is responsible for encouraging, planning and executing research in the physical and biological sciences relating to the natural environment and its resources.

1.2 In achieving its objectives NERC:

- (i) carries out basic, strategic and applied research funded from the Science Budget and by UK and overseas customers from the public and private sectors;
- (ii) supports research in its own institutes, and research and postgraduate education in HEIs;
- (iii) carries out survey and monitoring tasks in the execution of its Science Budget and commissioned research;
- (iv) provides supporting services and facilities to the environmental science community in NERC institutes and HEIs.

1.3 NERC provides information on its research activities and expenditure through its Annual Reports, Corporate Plans and other publications, and to the Cabinet Office Annual Review of Government Funded Research and Development.

1.4 NERC has noted the increasing emphasis that is being placed on the use of assessment procedures and indicators to evaluate and compare research performance. Accordingly NERC welcomes the review of R&D

definitions as a means to ensure compatibility and coherency in future evaluations and comparisons of research activity.

1.5 Environmental research is increasingly carried out in partnership with overseas groups or within the framework of international science programmes. This, together with the expanding role of the EC in research, underlines the importance of ensuring that common definitions are used between countries in defining R&D expenditure. NERC notes the planned revision of the Frascati definitions by the OECD, and welcomes the intent of the House of Lords Sub-Committee to contribute to the revision of the Frascati definitions.

2. QUESTIONS RAISED BY THE SUB-COMMITTEE

Responses to the 8 questions raised by the Sub-Committee are given in the following paragraphs.

3. *Question 1: Do you use the Frascati definitions in making returns to the "Annual Review of Government funded R&D"? If not what definitions do you use?*

3.1 Yes: The DTI Statistics Division requires the Frascati definitions to be used.

3.2 To date NERC has made little use of the Frascati category "experimental development". This could change in the future as a consequence of a greater involvement by Council in a range of very specialised development activities that are needed to support NERC research programmes. Examples of programmes where there is a significant development component are: advanced instrumentation; information handling; environmental modelling and associated software for marine and other purposes.

4. *Question 2: Do you use the same definitions in your day to day operations, or is it necessary to use other definitions? If so how do these definitions differ from those used in the Annual Review?*

4.1 The classification of the different activities supported by NERC as a part of our day operations is done on the basis of such factors as: areas of science (Earth sciences, marine sciences etc); funding source (Science Budget or other); expenditure type (salaries, capital equipment etc) and location (institute/HEI) where the expenditure occurred. It follows from this that the Frascati definitions are of little value for the day to day management of NERC programmes.

5. *Question 3: Do you experience any difficulty in converting your figures for R&D spending into the format required for the Annual Review? Do you encounter any other problems in making returns to the Annual Review?*

5.1 A principal difficulty in providing figures for R&D spending for the Annual Review is the suspicion that different contributors are interpreting the definitions of R&D in different ways. More precise definitions and/or clear guidelines on the application of the definitions are needed particularly in the separation of basic from strategic research (see Table 1.22 in 1988 Review).

5.2 A more detailed problem is that the NERC accounting system is not geared to producing figures net of VAT input tax, which is a requirement of DTI.

6. *Question 4: What explanatory notes or guidelines do you use in interpreting the Frascati definitions? Are they adequate for this purpose? What degree of subjectivity is involved in categorising your R&D spending?*

6.1 NERC uses the guidelines provided by DTI in interpreting the Frascati definitions.

7. *Question 5: Do the Frascati definitions provide a clear means of differentiating between: a) basic and applied research; b) research and development; c) between R&D and other related activities; for the purpose of:*

- i) compiling statistics of your Council's R&D spending;
- ii) compiling R&D statistics within a scientific and/or industrial sector;
- iii) comparing R&D activity between scientific and industrial sectors;
- iv) Making international comparisons of R&D activity?

7.1 A 12 part answer with explanatory notes is given following the matrix structure of the question:

	a)	b)	c)
i)	no (2)	(1)	no (3)
ii)	no (2)	(1)	no (3)
iii)	no (2)	(1)	no (3)
iv)	no (2)	(1)	no (3)

Notes:

1. Not widely applicable at present to NERC
2. Strategic research, which is not currently included in the Frascati definitions, forms an important element of the research carried out or supported by NERC. The Annual Review of Government Funded Research and Development includes a definition of strategic research as a

sub-category of applied research not yet advanced to the stage where eventual applications can be clearly specified.

3. NERC carries out extensive survey operations through the work of the British Geological Survey (BGS). These activities with their focus on map production, data gathering, database management and data processing do not fit into the Frascati definitions. In addition NERC's role in monitoring, the collection and storage of data over long periods of time, is a traditional and expanding activity for the environmental science community. Again this type of activity is lost within the broader definitions used in the Frascati manual.

8. *Question 6: What are the specific inadequacies of the Frascati definitions, and how might they be amended? For example, the OECD is considering supplementing the "basic" and "applied" research categories with a "strategic" research category.*

8.1 We support the OECD proposal to include a new and separate "strategic" research category. Care will be needed to provide a definition of strategic research that is unambiguous.

8.2 The Frascati definitions are highly subjective and care is needed in defining research categories. Much of the research that is supported by NERC has the potential for practical utility and application. As an example research into atmospheric chemistry and the depletion of the ozone layer, whilst undertaken to gain insight to fundamental scientific issues, can equally have important practical value and application to society. Such an activity can be differently classified depending on the timing and the context of the question.

8.3 The Frascati definitions do not include survey and monitoring activities which provide essential underpinning to many research programmes.

9. *Question 7: Would you give specific examples of work funded by your Council in 1986-87 which was recorded under each of the headings in Table 1.22 of the 1988 "Annual Review of Government Funded R & D".*

9.1 Basic Research:

Examples of basic research undertaken by NERC in 1986-87:

- (i) British Institutions Reflection Profiling Syndicate (BIRPS): A NERC-led community project involving universities, research institutes and industry to investigate the deep structure of the UK and adjacent areas.
- (ii) Ocean Drilling Program (ODP): An international programme aimed at providing a global view of the Earth's structure and history.
- (iii) Population dynamics of ciliated protozoa in productive lakes.
- (iv) Molecular biology of microorganisms.
- (v) Physiology of marine animals and their adaptation to the physical and biological features of the marine environment.

Much of the research that NERC supports in HEIs falls into the category of basic research.

9.2 Applied-Strategic:

Examples of NERC supported research that falls into the applied-strategic category are:

- (i) Elements of the NERC British Geological Survey (BGS) geological survey of the UK landmass and continental shelf.
- (ii) Land-atmosphere exchange of NO_x , O_3 , and NH_3 .
- (iii) Water use efficiency of rain fed crops.
- (iv) Research into the interactions between chemical contaminants in the aquatic environment and the biota.
- (v) Research into the 3D hydrodynamical processes of the North Sea with the aim to produce transport models capable of predicting water quality and pollution levels.

9.3 Applied-Specific:

Examples of NERC supported research that falls into the applied-specific category are:

- (i) Mineral resources and reconnaissance in the UK and overseas.
- (ii) Ecological appraisal of a potential power station site.
- (iii) Blue tongue virus diagnosis and vaccine development.
- (iv) Interaction between fish farming and the marine environment.
- (v) Studies to investigate the interaction of nutrients, particularly nitrogen, and marine phytoplankton.

Many of the "applied-specific" research projects undertaken by NERC are funded in total or in part by external customers.

10. Question 8: Did any of the work which you funded in 1986-87 fall outside the Frascati definition of R & D, but within the range of related activities which you have difficulty in distinguishing from R & D? If so would you provide examples of those activities with which you have had difficulty. Was this spending included in Table 1.22? If not where was it recorded?

10.1 NERC supports a number of activities in the areas of: data handling (eg the Biological Records Centre); elements of survey and monitoring work which do not fit into the current Frascati definitions. All of these activities are closely connected and in many cases provide essential underpinning to NERC's research programmes. As a result there is a case for having a separate category that covers such programmes. These activities were included in the applied-strategic category on Table 1.22 in the Annual Review.

11. Question 9: It has been suggested that the number of scientifically and technically qualified personnel employed in R & D is a better indicator of R & D effort than is the figure for R & D spending. Do you agree?

11.1 A certain amount of manpower information is made available on the R & D returns to the DTI (Form 80), but an analysis of this data would run into the same classification as currently found with expenditure. There would also be the additional problems associated with classifying the manpower itself, eg Directors and other scientifically graded staff who are not actual researchers, plus administrative and other support staff who all provide important support to the whole research programme.

11.2 Consideration should be given to using both expenditure and personnel employed in R & D together to provide a better indicator of R & D effort.

NERC.

July 1989.

Memorandum by Northern Ireland Departments

Q1 The Frascati definitions are used in making returns to the Annual Review of Government Funded R&D.

Q2 The same definitions are used in day-to-day operations.

Q3 The only difficulty has been that in the past the HMT Ready Reckoner has been used to calculate staff costs and overheads and this does not reflect the actual staff costs etc. Also the cost of computer and computer staff time actually devoted to R&D has had to be estimated. However, for 1988 onwards actual expenditure on staff can be provided and systems have been developed to accurately cost computer time etc.

Q4 Notes for survey forms provided by DTI are used and these are adequate. Most of the research falls within the categories provided. However, there is an element of ambiguity in the sub categorisation of objectives as research often overlaps and will have more than one objective.

Q5 NI Departments have expressed no difficulty in differentiating between, basic and applied research; research and development; and R&D and other activities. The definitions also provide reasonably clear guidance on (i)-(vi) of this question.

Q6 Apart from the comments at question 4 departments find the definitions adequate. We have no other comments to make or suggested amendments.

Q7 (a) *Basic*

(i) Control of Neurotransmitter releases from the Sympathetic nerves to Bovine Sympathic Smooth Muscle.

(ii) Enzymology of halomethane production by fungi.

(b) *Applied—Strategic*

(i) Development of Very Low Birth Weight Children.

(ii) Research into the development of compaction control test for bituminous materials.

(iii) Construction of acid/aluminium tolerant strains of *Rhizobium* by genetic manipulation.

(c) *Applied—Specific*

(i) The Continuous Household Survey—a multipurpose study designed to produce information on the social and economic circumstances of families in Northern Ireland.

(ii) Violence and Community Relations—the impact of political violence in Northern Ireland on intra-community, inter-community and community-state relationships.

(iii) Determinants of Labour Supply.

(iv) Family Expenditure Survey—up-to-date information on the cost of living and its effect on families.

(v) Young Offenders in the Community Programmes.

(vi) Counselling with the unemployed.

- (vii) Work Sharing in the NI Civil Service.
- (viii) Economic Study of the effects on manufacturing industry in NI of increasing the charges for treating trade effluent discharge.
- (ix) Survey into the impact of the Enterprise Allowance Scheme in NI.
- (x) Inter-regional Study of Small Firms.
- (xi) The nutritional requirement of Sitka spruce on oligotrophic blanket peat.
- (xii) Drinking Water Quality—methods of meeting EC Directives.
- (xiii) Research on Discharge of sewage to sea.
- (xiv) Determination of preferred methods for sludge disposal to land as an alternative to dumping at sea.
- (d) *Experimental Development*
 - (i) On-farm use of growth regulators with spring and winter barley in Northern Ireland.

Q8 To the best of our knowledge only work funded by NI Departments in 1986-87 falling outside the Frascati definition was an investigation into incidents of Child Sexual Abuse in Northern Ireland. This was included with projects reported under row 32 of the form 77.

Q9 In the case of the Department of Finance and Personnel (NI) for example, R&D has a primary purpose 2. This additional information identifies the work as orientated towards the needs of Government rather than any other purpose. This classification would, therefore, appear to be supplementary rather than alternative.

Q10 Central UK Departments might be better placed to respond to this question.

Q11 The number of scientifically and technically qualified personnel employed on R&D is *an* indicator though it is not necessarily a better indicator of effort. Some research requires high capital spend, other research is more labour intensive. It might be useful to split headings into:

- (a) salaries and wages;
- (b) capital scientific expenditure;
- (c) scientific consumables expenditure; and
- (d) overheads.

Memorandum by the Overseas Development Administration

1. *Do you use the Frascati definitions in making returns to the "Annual Review of Government Funded R&D"? If not what definitions do you use?*

Frascati definitions are used as instructed.

2. *Do you use the same definitions in your day-to-day operations, or is it necessary to use other definitions? If so how do these definitions differ from those used in the Annual Review?*

Definitions used by ODA are the same as Frascati except that ODA's Natural Resources & Environment Department uses the term "adaptive research" instead of the Frascati term "specific research".

3. *Do you experience any difficulty in converting your figures for R&D spending into the format required for the Annual Review? Do you encounter any other problems in making returns to the Annual Review?*

The ODA annual Report on R&D which lists projects with location, duration, total and annual costs is a necessary precursor to this exercise. Forecasting of location, type and staffing of research work 4 years hence must necessarily be based on current Aid Framework and policy. NABS (see para 15 of DTI Notes attached) classification is particularly subjective although the Ready Reckoner is used, year 1 being categorised with the knowledge of the current programme but for years 2 and 3 the same pattern is assumed. Calculating ODA staff costs is again subjective especially as no one officer is employed full time on administering this research. We are guided internally on overhead costings, but would be further assisted by provision of the latest edition of the "Ready Reckoner for staff and other costs" with the request for figures. The task is complex and the instructions vary from year to year and even within the year.

4. *What explanatory notes or guidelines do you use in interpreting the Frascati definitions? Are they adequate for this purpose? What degree of subjectivity is involved in categorising your R&D spending?*

We use the DTI Notes for survey forms—copy attached. Some ODA research funds are used for activities which are excluded according to the Frascati definitions, e.g. dissemination of research work and contributions to programmes (often multilateral) which consist of both operational and research activities. ODA activities are not covered by primary purposes, Section 19 of the DTI notes. We describe ODA activities as being "To gather new knowledge and evolve new techniques directly related to the needs of developing countries for

practical use in a reasonable period of time, emphasis on the needs of the poorer sections of the poorer countries." ODA find little difficulty in defining basic and applied research but within applied research there is sometimes difficulty in distinguishing between "strategic" and "specific".

5. *Do the Frascati definitions provide a clear means of differentiating between:—*

a. *basic and applied research*

Yes

b. *research and development*

The Frascati definition clearly differentiates between research and experimental development but in practise there is sometimes difficulty in distinguishing between experimental development and applied specific research.

c. *R&D and other related activities*

Yes.

for the purposes, in each case, of

- i. *compiling statistics of your department's R&D spending;*
- ii. *compiling R&D statistics within a scientific and/or industrial sector;*
- iii. *comparing R&D activity between different scientific and industrial sectors;*
- iv. *making international comparisons of R&D activity?*

i-iv Yes. Frascati definitions give us the facility to address these purposes, but in practice this rarely occurs.

6. *What are the specific inadequacies of the Frascati definitions, and how might they be amended? For example, the OECD is considering supplementing the 'basic' and 'applied' research categories with a 'strategic' research category. The United States Department of Defense sub-divides 'experimental development' into 'exploratory', 'advanced' and 'engineering' development (Annex 2). Would there be any advantage in using these, or other, categories to classify your department's R&D spending?*

The Frascati definitions are adequate. Referring to the OECD example the Cabinet Office have already extended Frascati to include strategic research as a sub-division of applied research. We see no advantage in changing this. The USA sub-divisions appear unnecessarily cumbersome.

7. *Would you give specific examples of the work funded by your department in 1986-87 which was recorded under each of the headings in Table 1.22 of the 1988 'Annual Review of Government Funded R&D', ie:*

- a. *basic;*
- b. *applied—strategic;*
- c. *applied—specific;*
- d. *experimental development.*

All ODA R&D was applied — specific. While ODA recognises the facility for categorising the research by Frascati definitions, the specific instructions given for 1986-7 (see attached) meant all ODA R&D was categorised as applied specific research.

Project description	Country of primary research	Project leader and/or Institution	Total cost to ODA £	Cost to ODA in 1986-87 £	Starting date and duration
Resistance mechanisms of Rice to Brown Planthopper	UK	Dr A. Cook ODNRI, London	313,600	107,200	1984 5 years
Diseases of pines in the tropics	UK/Developing Countries	Dr M. H. Ivory Oxford Forestry Institute	149,100	36,200	Apr. 1983 4 Years 1 month
Water conserving sanitary systems for developing countries	UK	Dr J. A. Swaffield Brunel University	154,200	46,000	Jan. 1983 4 years 3 months

8. *Did any of the work funded by your department in 1986-87 fall outside the Frascati definition of R&D, but within the range of related activities which you have difficulty in distinguishing from R&D? If so would you provide specific examples of those activities with which you had difficulty. Was the spending on these activities included in Table 1.22? If not where was it reported?*

Some R&D work funded by ODA did fall outside the Frascati definition of R&D, see 4 above, and was excluded in accordance with the DTI definition of 'activities to be excluded from R&D' see paragraph 7, DTI Notes for PES Survey 1987. There was no difficulty in distinguishing these activities from the Frascati R&D work.

The excluded work was not reported in Table 1.22, but was, together with all ODA's R&D activities, included in the ODA annual Report on R&D.

9. *The 'Annual Review of Government Funded R&D' also classifies R&D spending according to 'primary purpose'. How does this classification differ from Frascati? What advantages, if any, does this classification have over Frascati?*

This classification differs from Frascati in that it relates to motive for the work rather than the stage of the research and development process involved in the attainment of the objective. Primary purposes definition of R&D has no particular advantages or disadvantages for ODA over Frascati R&D definitions because ODA activities are not covered under Section 19 of the DTI Notes (see 4 above).

10. *In the 'Annual Review of Government Funded R&D' there is an 'apparent discrepancy' between the amount that government says it spends on R&D in industry and what industry says it receives from government. How does this situation arise and how can it be improved?*

The Department of Trade and Industry is best placed to answer this.

11. *It has been suggested that the number of scientifically and technically qualified personnel employed on R&D is a better indicator of R&D effort than is the figure for R&D spending. Do you agree?*

These are two distinct indicators which are not mutually exclusive; neither may be used as a sole indicator of research effort or activity. R&D effort is essentially the resultant of the number and capabilities of researchers employed. Expenditure is a necessary enabling factor, but so too are other factors such as good management. Expenditure required per researcher varies widely according to the nature of the project.

PUBLIC EXPENDITURE SURVEY 1989

CENTRAL GOVERNMENT EXPENDITURE AND EMPLOYMENT ON RESEARCH AND DEVELOPMENT IN SCIENCE AND TECHNOLOGY, AND SOCIAL SCIENCE

NOTES FOR SURVEY FORMS 77, 78 AND 79

INTRODUCTION

1. This annual survey is conducted by the Department of Trade and Industry to obtain details of central government expenditure on research and development (R&D). The data, together with similar details from surveys of R&D in the industrial and other sectors, are used to produce estimates of the national R&D effort. The results of this survey are also needed to fulfil the United Kingdom's obligation to the European Community to provide annual details of government R&D expenditure. Moreover, there is considerable and continuing public interest in the whole question of investment in the future, and up to date statistics of R&D expenditure in the UK provide important indicators in this area.

2. Another important use for these statistics is to provide tables for the "Annual Review of Government Funded R&D", published by the Government Statistical Service and HMSO for the Cabinet Office. The Fifth Review appeared in 1987 Annex 1 of the Review describes the authority for conducting the series.

DEFINITIONS USED IN THE SURVEY

3. The survey uses the definitions of the "Frascati Manual" ("The Measurement of Scientific and Technical Activities", published by the Organisation for Economic Co-operation and Development (OECD) in Paris, in 1981). Summarised passages from the manual are set out below for general guidance, in paragraphs 4 to 7.

RESEARCH AND DEVELOPMENT

4. Research and experimental development may be defined as creative work undertaken on a systematic basis to increase the stock of knowledge of man, culture and society, and the use of this stock of knowledge to devise new applications. R&D must be distinguished from a wide range of related activities with a scientific

and technological base. These related activities are closely linked to R&D in terms of operations, institutions and personnel, but they should, as far as possible, be excluded when measuring R&D. The criterion for distinguishing R&D from non-R&D activities is the presence or absence of an appreciable element of novelty.

TYPES OF R&D WORK

5. The Frascati manual identifies three types of R&D work, and suggests that it is appropriate to analyse only intramural current spending in the field of science and technology. The annual review makes a further distinction in one area (see paragraph 6) and extends the concept to include spending on R&D in the field of the social sciences and humanities. Careful note needs to be made of the important difference between the two cases. Frascati identifies:—

Basic research—original investigation undertaken in order to gain new knowledge and understanding. It is not primarily directed towards any specific practical aim or application, but may be oriented towards an area of interest to the performing organisation.

Applied research—original investigation undertaken in order to gain new knowledge. It is, however, directed primarily towards practical aims or objectives.

Experimental development—the use of existing knowledge in order to produce new or substantially improved materials, devices, products, processes, systems or services. This includes the design, construction and operation of prototypes and pilot plants.

Responses to the request for a breakdown of current intramural costs, in boxes 91 to 93 of question 4 in form 74, should be based on the definitions in this paragraph.

6. The Annual Review seeks to distinguish between two types of applied research—

Applied research may have either **strategic** or **specific** aims. Strategic research may be initiated at the suggestion of researchers doing basic research in a particular field because they consider that practical applications are likely and feasible but cannot yet be specified in detail ('technology push'). Alternatively, strategic research may arise as a result of a Government Department's belief that the accumulation of underlying technological know-how will serve many diverse purposes ('market pull').

Boxes 31 to 34 of forms 77 and 78 allow applied research to be divided between strategic and specific aims, and for the concept to be extended to include the whole of R&D, intramural and extramural, scientific and technological with social science and humanities.

In this respect it is likely that basic research may be carried out by Universities and Research Council institutes at the initiative of the research community, being funded from general university funds and the science vote. Such work has a 'strategic' dimension, in that those funding it consider long-term practical benefits will result. However, identification of the extent of a strategic element of basic research is not easy, and is not required for this exercise. (A fuller account of these terms can be found in annex B, of the 1987 Annual Review, to which those responsible for completing form 79 will find it useful to refer when preparing their replies.)

ACTIVITIES TO BE EXCLUDED FROM R&D

7. The following related activities should be excluded from the measurement of R&D throughout the questionnaire:—

Education—all education and training of manpower in the fields of science, engineering, medicine, agriculture, the social sciences and the humanities, in universities (including post-graduate training) and in specialised institutions of higher and post-secondary education, except for the element of university research which is carried out by post-graduates as part of their research training.

Scientific and technical information services – the specialised activities of collecting and disseminating information, e.g. bibliographic services, official scientific and technical information services, except where these are conducted solely or primarily for the purposes of R&D support.

General-purpose data collection – concerning, for example, the medical situation, the natural environment (routine topographical mapping, geological, hydrological and oceanographic and meteorological surveying as well as routine astronomical observations) and exploration and prospecting activities of oil and mining companies, except where the data collection is conducted solely or primarily as part of the R&D process.

Testing and standardisation – the maintenance of national standards, the calibration of secondary standards and the testing and analysis of materials, components, products, processes, soils, atmospheres, etc. (Note that research into methods of testing and standardisation is included in R&D.)

Feasibility studies for engineering projects – investigation of proposed engineering projects by means of existing techniques in order to provide additional information before deciding on implementation.

Specialised medical care – except where there is an element of experimental development.

Patent and licence work – all administrative and legal work connected with patents and licences.

The costs of trial production runs of "experimental production" including tooling up for full scale production (tool making and tool try-out) should not normally be included in R&D unless technical problems that are encountered require further R&D work. For example, after a new product or process has been turned over to production units there will still be technical problems to be solved, some of which may demand further R&D. Such "feed-back" R&D should be included.

ECONOMIC SECTORS

8. Central government covers the central government sector in Great Britain and Northern Ireland as defined for national accounts purposes. Public corporations are also those bodies so defined for national accounts purposes (see the list of public corporations in the CSO "Blue Book", United Kingdom National Accounts, 1987 edition, HMSO). Universities and further education establishments include universities in the United Kingdom and local authority establishments of further education. Non-industrial research institutes include those associated with universities but financed by government. "Other" includes local authorities (other than local authority further education establishments).

COMPLETING THE QUESTIONNAIRES

9. The questionnaire is in three parts. Form 77 seeks details of outturn expenditure for the financial year 1986/87. Form 78 extends the time scale of the inquiry from 1987/88 to 1990/91. Form 79 is to be used for supplying details specifically for the Annual Review. Your completed forms 78 and 79 may be sent to DTI separately from form 77.

10. It is important that the full costs of R&D be reported, and that costs are not reported twice. In particular, where part of the cost of R&D activities may be met from sub-programmes not normally associated with R&D, then these secondary costs should be included in the responses to questions 1 to 8. Examples of this situation occur with accommodation and staff costs. You are asked to complete a separate set of forms 77, 78 and 79 for each sub-programme (PES head) under which R&D expenditure occurs. The secondary costs of the support for R&D should be included, estimated from other sub-programmes if necessary. These supporting costs should include the employers' element of National Insurance contributions and the implied cost of the non-contributory superannuation scheme within "wages and salaries", and the full cost of administration, as detailed in the heading for "other expenditure". In particular, the cost of staff whose role may be purely administrative, disbursing grants for R&D performed outside the Department, should be included in headings 1 to 4, together with the staff costs of persons included in headings 35 to 39. You will find the Treasury "Ready Reckoner for Staff and other costs" useful in making these estimates.

11. Expenditure figures should be shown to the nearest £1,000, **exclusive of VAT**, and where figures can only be estimated approximately or allocated on an arbitrary basis, this should be recorded in a footnote or covering memorandum. Lines numbered 30 in the questionnaires 77 and 78 should show a total which can be reconciled with the relevant totals in the Public Expenditure Survey (PES).

12. In contrast to the requirements of the main public expenditure survey, gross expenditure (line 22) and receipts appropriated in aid (line 29) need to be detailed separately for these surveys. The difference between the totals in these two headings appears in line 30.

13. Expenditure on R&D performed outside the government sector includes all current and capital grants and may involve the free supply of goods and materials, etc. If the cost of purchasing such items is not included in the main PES return this should be noted in a covering memorandum. In form 77 current expenditure on intramural R&D in line 4, is analysed in lines 91 to 93, according to the type of work being undertaken—basic research, applied research or experimental development, as defined in paragraph 5 above. In lines 31 to 34 a similar analysis is needed for the total net expenditure in line 80, but using the additional definitions of strategic and specific applied research, in paragraph 6. Note that in this second case the **whole** of net spending in line 80 is used.

14. In lines 35 to 39 the number of people employed on intramural R&D should be the full-time equivalent (in whole man-years) of the number of man-hours devoted to this type of work. All personnel whose wages and salaries are shown in line 1 of forms 77 and 78 should be included, even though some may be unskilled support staff or involved solely in administration or maintenance.

15. The questionnaire asks for an analysis of the total net R&D expenditure in line 30 by the "objectives", of the European Community classification for analysing science budgets (NABS, a French acronym for "Classification for analysing and comparing science budgets and programmes"). Similar analyses, by these same objectives, are needed for expenditure on international projects, and also for payments to private and public industry for work performed outside the government sector. The NABS objectives are listed separately from this questionnaire, with the code numbers for each of the defined headings. The appropriate two-digit codes should be entered in the columns of forms 77 and 78 and if your return needs more objectives than the page allows please continue on a separate sheet. For the financial year 1988/89 figures analysed at the level of NABS chapter heading, only, are required.

QUESTIONNAIRE FORM 79, for the ANNUAL REVIEW OF GOVERNMENT EXPENDITURE ON RESEARCH & DEVELOPMENT

SUBJECT AREAS

16. The Annual Review requires an analysis of the total net expenditure for each year of the review period, as shown in line 80 of forms 77 and 78. These totals should be subdivided into subject areas and identify the main objective or **primary purpose** (pp) of the expenditure. The primary purposes are defined in paragraph 19, below.

17. Subject areas should be clearly defined and fully reflect the PES sub-programme you have entered on the front page of form 79. Often, each PES sub-programme will cover only one subject area. Where there is more than one, each should be entered separately with the appropriate primary purpose code (see below). You may find that your form has already been completed with some of the subject areas used in last year's form 76. Please check that expenditure on these areas is still occurring, and continue the series with new information as necessary. If there are more subject areas than room available please ask for further copies of the form, from DTI (telephone numbers on the front of the form). The subject area descriptions should be those used within the department or Research Council, in published annual reports, etc. These should be as explicit and informative as possible.

PRIMARY PURPOSES

18. Previous requests for Annual Review statistics have required the simultaneous relationship between the type of research, as defined in paragraphs 5 and 6 above, and the primary purpose. This is no longer required, but respondents should ensure that their series for each of the two concepts are consistent with their returns in earlier surveys. It is important that the level of basic research, for instance, is not seen to change merely because it is no longer entered in the form in direct association with the primary purposes.

19. The primary purposes, together with the single digit code to be used in form 79, are as follows:—

- pp1 Advancement of science—Work funded primarily in order to increase human knowledge, i.e. to advance scientific understanding of natural phenomena. This research contributes to the scientific base of the nation and, although originally funded with no specific application in view, much of it eventually results in long-term benefit through the eventual application of knowledge gained. The heading is equivalent to the OECD term 'basic research', as above.
- pp2 Support for policy formation and implementation — Applied research (some of which may be strategic in nature) and experimental development carried out in order to meet governments' own needs for knowledge or improved products or processes. For example:—
 - To identify and assess policy options (e.g. on choice of renewable energy resources, or measures to deal with social or environmental problems).
 - To facilitate forward planning (e.g. on the efficient use of the radio spectrum).
 - To make the provision of government services (e.g. defence or health) more effective and efficient.
- pp3 Improvement of technology—Applied R&D funded by Government departments but often carried out within industry, to advance the technology of different sectors of the UK economy — manufacturing, agriculture, construction industries, etc. Some of the research may be strategic in nature.
- pp4 Support for purchasing decisions—Applied R&D which contributes to the specification and development of goods and services required by Departments (mainly related to defence needs) and to equip the purchasing department to act as an informed buyer.
- pp5 Support for statutory duties—Applied R&D which assists departments to carry out statutory responsibilities or other obligations (e.g. in connection with the Health and Safety at Work Act, or building regulations).
- pp6 Support for scholarship in the humanities— Research on the support and promotion of scholarship to increase appreciation and understanding of the humanities.
- pp7 Support for other activities—Applied R&D which cannot be classified under the other headings (e.g. research to support economic or agricultural progress in developing countries).

The support for other activities category, pp7, should be used if codes 1 to 6 do not match the objectives of a particular subject area. The title of the subject area should be expanded in these cases, to indicate those objectives. When R&D is carried out for two or more quite distinct primary purposes within one subject area then separate entries for each part of the programme should be made in form 79. This situation would arise for instance, when considering housing research. It may be for 'difficult-to-let' estates (pp2) or the setting of building regulations (pp5). Distinctive titles should be given in the subject area column, departmental research in more than one primary area may be departmental science (pp1), departmental technology (pp3) and departmental regulations (pp5).

Memorandum by the Science and Engineering Research Council

GENERAL COMMENTS

The Frascati definitions seem to us fairly well suited to their purpose. It is impossible to imagine a perfect system; in particular the act of using the definitions to classify activity will always be to some degree subjective i.e. it will be a function of the perceptions of the persons doing the classifying.

It follows that year-on-year change for any one organisation or country can be given significance, but not that place-to-place comparisons necessarily mean much. Only by including a dynamic can the latter lead to grounds for valid comment - e.g. that the Germans have increased A by x % in 5 years whereas the French have y % for the same change.

The questionnaire

Question 1 We do use the Frascati definitions in making our returns though there are some interpretational difficulties (see later).

Question 2 We do not use the Frascati definitions in our day-to-day operations principally because they do not cover the totality of the Council's expenditure, technology transfer and MSc training being significant items which fall outside Frascati. In the main we see these excluded items as being of strategic importance and adopt a broad brush operation definition to monitor the trends over time within SERC (Annex A).

Question 3 Accounting difficulties arise because:

- (i) it is necessary to exclude certain items of non-Frascati expenditure;
- (ii) the Annual Review of Government Funded R&D figures are exclusive of VAT on expenditure.

Other difficulties arise because of timing. It has been the Council's practice to review expenditure by Frascati definitions on an annual basis and it would be more convenient if returns for the whole period of the Annual Review were called for at a later date. It is particularly difficult to accommodate the requirement for a basic/strategic split on Form 80 for the first year of the Annual Review ahead of all other years. Generally the data are called for by the end of January causing severe problems for the current and future years because:

- (i) the outturn for the current year has to be estimated;
- (ii) the allocation for forward PES years has only been recently agreed by the ABRC and its distribution to activities within SERC may not have been decided by Council. This results in a need to work on provisional figures and later revise them.

If responses were called for by the end of April each year outturn data would be reasonably precise and it would not be necessary to rework provisional figures since Forward Look allocations could be used. It is for note that the work on the Annual Review returns presently falls at the time the Council is preparing Estimates and Forward Looks, is monitoring closely the outturn position and, in some years, is finalising its Corporate Plan. Conflicts often arise between these work requirements.

We also experience some difficulty due to inconsistency between Form 80, which seeks extra-mural international expenditure (at Question 16) while Form 83 seeks the subdivision of this to include intra-mural expenditure.

Question 4 We have used the summary Frascati definitions of Basic Research, Applied Research and Experimental Development in guidelines to the staff who categorise the expenditure. The Frascati manual is available to resolve specific questions. A certain degree of arbitrariness enters into the categorisation. To take two examples, taught courses (MSc training) may include novel research projects but they are all classified as non-Frascati R&D. Conversely doctorate courses (PhD) might not be all research, and can have a taught course element, but we regard them as Frascati R&D. The Council's Co-operative Awards in Science and Engineering (CASE Studentships) may in some cases be in effect for technology transfer but we regard them as applied (strategic) R&D. Further elaboration of the difficulties are set out in response to Question 5.

Question 5 The Council's primary activities are either basic or applied strategic research and, we are uncertain whether having only two "boxes" to choose from makes it more or less difficult than with a broader spread of activity and hence more choice. In many areas the Council supports a continuous spectrum of research from basic to strategic and whilst the ends of this spread will be clearly basic or applied strategic there can be a large area between where the distinction is not obvious. In some cases an individual project within a programme may have both basic and strategic elements. It was recognised from the early days of the Annual Review that basic research as funded by Research Councils (and universities) could have a strategic dimension from which longer term practical benefit might result but it has been accepted that this strategic element cannot be identified easily or quantified. This element is recorded as basic research for the Annual Review. As time progresses the borderline between strategic and basic research is becoming increasingly blurred because the time required to exploit fundamental discoveries is shortening; the distinction will become even more uncertain.

We do not have great difficulty in identifying and distinguishing between research and development and between R&D and related activities primarily because SERC has so little involvement with these activities that the ones that are supported are straightforward to categorise.

Question 6 The difficulties result from the requirement in Frascati to identify a specific dividing line in what is a continuum of research and development activity. The subdivision of the applied research category within the Annual Review to some extent compounds the difficulties. Since the majority of the Council's own research is either basic or applied strategic we are in essence already endeavouring to distinguish between basic and strategic categories and would have the same difficulties if an OECD strategic category was incorporated since it would probably draw on both basic and applied categories.

Question 7 The work funded by the Council is recorded in the SERC entry beginning on page 181 of the 1988 Annual Review. The major features are:

- (i) basic: Nuclear Physics (including CERN), Astronomy and Planetary Science (including European Space Agency), part of Science Board.
- (ii) applied strategic: Engineering Board, majority of Science Board.

Question 8 The items outside Frascati are recorded on page 185 of the 1988 Annual Review under the heading "Technology Transfer and Other Non-Frascati Activities". The Teaching Company Scheme in particular is one that we regard as being of strategic importance but which under the Frascati definitions is Technology Transfer.

Question 9 Personnel numbers are a useful additional indicator but not a substitute for expenditure because there is a very large variation between branches of science in the capital investment needed to pursue research, exemplified by the terms "big science" and "little science".

In formulating corporate objectives and subsequently monitoring performance, one of the indicators used by SERC relates to the nature of research. A simple division into two types—Basic and Strategic—is adopted to reflect the intuitive view that SERC's activities do indeed cover these two types of research. The classification of activity is pre-defined in terms of which of the Council's four Boards is supporting it, as shown in the table below. Administrative and other central costs are distributed pro rata. The indicator is used for both total domestic expenditure and for grand total expenditure, and has proved satisfactory.

Basic comprises	Strategic comprises
90	10% of Astronomy and Planetary Science
0	100% of Engineering
100	0% of Nuclear Physics
20	80% of Science

Memorandum by the Scottish Office

BACKGROUND

Of the total estimated expenditure by the SO on R&D in 1988/89 of some £55 million, approximately £44 million (ie 80%) is channelled via the Department of Agriculture and Fisheries for Scotland (DAFS) and the bulk of that is Agricultural. Thus the response to this questionnaire is based primarily on DAFS Agricultural Divisions' view but relevant complementary information and divergent views of other SO Departments and Agencies are added.

Question 1. Do you use the Frascati definitions in making returns to the 'Annual Review of Government Funded R&D'? If not what definitions do you use?

Answer 1. Yes the Frascati definitions are used. However, spending by the Scottish Development Agency on Technology Transfer activities falls out with the Frascati definitions and is reported in the text of the Annual Review (AR) rather than in the tables.

Question 2. Do you use the same definitions in your day-to-day operations, or is it necessary to use other definitions? If so how do these definitions differ from those used in the Annual Review?

Answer 2. Frascati and other definitions are used. The DAFS Agricultural programme is described initially in the format of the ARCIS information system. This comprises a matrix of research area X commodity with a Programme Unit forming one element within that matrix. A Programme Unit consists of a set of aggregated, related Research Objectives. The programmes of the various contractors are commissioned at the Programme Unit level. The whole DAFS-funded programme is subsequently categorised in a number of ways to meet the needs of the Annual Review (Frascati, Primary Purpose), the MAFF National Programme, and the Priorities Board. For DAFS own purposes, a new classification is being adopted comprising 7 Themes with associated sub-themes. Research Objectives are now used as the primary unit for each aggregation/classification:

On the Fisheries side, the Primary Purpose is more useful when the emphasis of a particular query is on what the work is being done for, rather than the nature of the work itself.

Question 3. Do you experience any difficulty in converting your figures for R&D spending into the format required for the Annual Review? Do you encounter any other problems in making returns to the Annual Review?

Answer 3. Yes. It tends to be the nature of the work described in DAFS Agricultural Research Objectives (ROs) that it does not fall discretely into single Frascati Categories. Each RO must thus be assessed for its percentage contribution to the 4 categories described in 7 a – b below. It would be quite exceptional for a single RO to span all 4 categories, but it is usual for an RO to span 2 categories at least.

For Fisheries R&D, a procedure has been developed to simplify the conversation of expenditure into the format required for the Annual Review. At the beginning of each year, the primary purpose code and the proportion of R&D (as opposed to non-R&D) is decided for each project in the programme of work agreed by DAFS customers.

Within the Scottish Home and Health Department (SHHD), the Chief Scientist's Office (CSO) finds it is necessary to translate expenditure which it categories for its own purposes under 4 main areas of research activity – health services, biomedical, equipment for the disabled, and scientific and medical equipment – to the headings used for the AR. It is not difficult, but is an additional time-consuming step which has to be taken, with no benefit to the CSO. The Frascati system is rather more sophisticated than the CSO needs and we wonder whether there is any scope for making simpler separate provision for such minor spenders. Frascati has been formulated for the big battalions; the relatively small amount of funds at the disposal of CSO, £5.1m in 1989-90, all used in the public sector, have a very marginal effect on the various relevant categories within the Annual Review. A further complicating factor for CSO is the fact that strictly it does not undertake R&D; it funds research. Related development, when it takes place is in the setting of the NHS and is funded from the general grant allocated to the Health Boards.

Similar points to CSO's are made by the Scottish Development Department (SDD) which has an even smaller R&D budget of around £1 million for 1988-89. A range of professional groups and clerical grades may be engaged in particular research and research may be only part of their duties. It is time-consuming for SDD staff to convert their own statistics into the format required for the AR.

Question 4 What explanatory notes or guidelines do you use in interpreting the Frascati definitions? Are they adequate for this purpose. What degree of subjectivity is involved in categorising your R&D spending?

Answer 4 Explanatory notes for the 4 categories are provided by DTI. These are reasonably helpful. It is the nature of research that it tends to be a continuum from basic to applied and development, and there are inevitably grey zones between the idealised descriptions given in the guidelines. Thus, some DAFS decisions are made subjectively but in as consistent and fair a way as possible. MAFF and DAFS have agreed common definitions to be applied in fisheries research, aiming at a more objective approach.

The Industry Department for Scotland (IDS) has a small budget for R&D (some £200,000 in 1988-89, for Economic Research). Apportioning the amount of staff time (in order to calculate the cost of internal research/supervision of external research) is a subjective process, particularly in relation to estimates for future years: it is difficult to provide such estimates as research projects often arise at short notice and other work impinges on time spent on research.

Question 5 Do the Frascati definitions provide a clear means of differentiating between:

1. *basic and applied research;*
2. *research and development;*
3. *R&D and other related activities;*

for the purposes, in each case, of:

- 3.1 *compiling statistics of your department's R&D spending;*
- 3.2 *compiling R&D statistics within a scientific and/or industrial sector;*
- 3.3 *comparing R&D activity between different scientific and industrial sectors;*
- 3.4 *making international comparisons of R&D activity?*

Answer 5 Regarding 3.1. There are always some doubts in Agriculture over deciding exactly what is basic research; in Fisheries it is more difficult to decide what is development. Problems are also met over data-gathering exercises where interpretation of the data may form a separate research objective. In such cases work has sometimes been described at S&T (Science and Technology) rather than R&D. We have also been asked by Whitehall for S&T figures which equate to Frascati + Technology Transfer.

Regarding 3.2-3.4. There is a minimal problem in comparing statistics compiled on an equivalent basis. Thus DAFS (Agriculture) can feel reasonably confident in comparing the nature of the research programmes of its different contractors. The problem arises when comparing statistics derived from different sources.

In DAFS (Fisheries), the main use of the Frascati definitions has been in compiling statistics of fisheries R&D spending with DAFS. The Frascati definitions have not been used much in the fisheries sector for the other purposes noted in the questionnaire (ie industrial activities and international comparisons).

Question 6 What are the specific inadequacies of the Frascati definitions, and how might they be amended? For example, the OECD is considering supplementing the 'basic' and 'applied' research categories with a 'strategic' research category.

The United States Department of Defence sub-divides 'experimental development' into 'exploratory', 'advanced' and 'engineering' development (Annex 2). Would there be any advantage in using these, or other, categories to classify your department's R & D spending?

Answer 6 Because of the continuum of research, subjective decisions on categorisation will always be necessary at the margins. The Frascati categorisation as refined by DTI already sub-divides "applied" work into "Applied — strategic" and "applied — specific." There could be some merit in having a category for "strategic" research in place of the "applied — strategic" category, but it would be very difficult to achieve a consistent separation between "strategic" and "applied — strategic" if both categories were adopted. Refinement of categories would still leave the problem of classifying consistently between adjacent categories and in addition requires even more detailed knowledge of the research programmes underway if they are to be categorised meaningfully. There is a distinct danger that such refinement will give the impression of a deeper and more precise analysis of the research programme than is justified by its determination in practise.

Naturally, the SO Departments with smaller budgets for R&D tend to bne against any such further disaggregation. The AR already absorbs a considerable proportion of time for them with no tangible payback — indeed the effort put into the AR must detract from the total R&D actually being done (or supervised).

Question 7 Would you give specific examples of the work funded by your department in 1986-87 which was recorded under each of the headings in Table 1.22 of the 1988 'Annual Review of Government Funded R&D', ie:

1. basic;
2. applied — strategic;
3. applied — specific;
4. experimental development.

Answer 7

1. Basic

Agriculture:—

- 1.1 Elucidation of the acute autocrine control of milk secretion.
- 1.2 Construction of detailed genetic linkage maps using molecular and isozyme markers.

2. Applied strategic

Agriculture:—

- 2.1 Characterising the spatial and temporal variation in soil and environmental properties by geostatistical methods.
- 2.2 Maintaining and evaluating the Commonwealth Potato Collection.

Fisheries:—

- 2.3 An example is the research being done on biological interactions in the sea. The aim is to determine the physical, chemical and biological interactions of marine phytoplankton and the zooplankton which provide the food supply for higher organisms such as fish and marine mammals. Particular attention is given to stages in the foodchain which are sensitive to natural or man-made environmental changes eg pollution, and to the mechanisms leading to the occurence of plankton blooms which can pose a threat to fish farmers.

(Other SO Departments had no entries in this category).

3. Applied specific

Agriculture:—

- 3.1 Test and model hill sheep production systems.
- 3.2 Identify methods of overcoming adventitious bursitis of the hock in growing pigs.

Fisheries:—

- 3.3 Work on the diagnosis, pathology and control of infectious diseases in farmed fish. The Department has responsibilities under the Diseases of Fish Acts for the investigation and control of disease outbreaks on fish farms. The research programme is undertaken to improve the diagnostic methods available to Departmental scientists, to develop better strategies for the control of important diseases such as furunculosis, and including the investigation of risks to wild fish stocks in the event of escapes of infected farm fish.

- 3.4 Work on how fishing gears select the fish which are caught as opposed to those which escape. The purpose of the mesh size regulations is to ensure that the small fish escape so that they can

grow to contribute to the fishery in later years. However, modern types of fishing gear have increased the proportion of young fish caught and the aim of the research programme is to show how more comprehensive controls on the fishing gear (covering other design features apart from the mesh size) might be introduced to avoid the undesirable mortality of young fish.

SHHD:-

- 3.5 Fines Officer Scheme Policy Evaluation.
- 3.6 Research studies on diversion from prosecution to social work assistance, remands, deferred sentences etc.
- 3.7 Evaluation of a Group of Drug Users in a Scottish City.

Scottish Education Department (SED):

- 3.8 Social Work Services Group: work done at Designated Research Centre at Stirling University.
- 3.9 Schools Effectiveness in Scotland.
- 3.10 Assessment of Achievement Programme.
- 3.11 Children with Special Educational Needs.
- 3.12 Further examples are contained in the Department's Annual Educational Research Register and a copy of the 1986-87 version can be supplied if required.

Scottish Development Department (SDD):

- 3.13 Impact of bus deregulation.
- 3.14 Evaluation of expenditure on housing modernisation and improvement.

4. Experimental development.

Agriculture:

- 4.1 Evaluating the performance of different laying strains under different housing and feeding systems.
- 4.2 Evaluating aerobic treatment in terms of reduction in environmental pollution, especially odour.

Fisheries:

- 4.3 Very little work under this heading (4.) is now undertaken by DAFS Fisheries Research Services. One example has been the development of a pressure vessel to induce triploidy in farmed salmon eggs. Triploid fish are sterile and have better growth characteristics from the fish farmers point of view. The R&D work has shown that the pressure method is more effective than the older alternative of inducing triploidy by applying heat. The further development of the triploidy pressure vessel has now been taken over by a commercial company and no further Departmental funding of this work is envisaged.

SHHD:

- 4.4 Development and Evaluation of Microcomputer based Aids for Occupational Therapy.

Question 8. Did any of the work funded by your Department in 1986-87 fall outside the Frascati definition of R&D, but within the range of related activities which you have difficulty in distinguishing from R&D? If so would you provide specific examples of those activities with which you had difficulty. Was the spending on these activities included in Table 1.22? If not where was it reported?

Answer 8. SDA Technology Transfer activities fall outside the Frascati definition of R&D. This spending was not included in Table 1.22 but specific reference was made in the AR text (page 127 of the 1987 AR). In the 1988 AR it was mentioned on page 134 of the text (estimated expenditure in 1987/88 = £600,000). For the 1989 AR it has been reported on Form 82A, introduced this year.

Question 9. The "Annual Review of Government Funded R&D" also classifies R&D spending according to 'primary purpose'. How does this classification differ from Frascati? What advantages, if any, does this classification have over Frascati?

Answer 9. A mixed response from SO Departments:

Agriculture:

The Primary Purpose classification partly overlaps with, but partly cross-classifies Frascati. Thus the Frascati "Basic" is taken to be equivalent to the PP "Advancement of Science". But the Frascati definitions for applied strategic, applied specific and experimental development can all be contained within other PP categories. The PP classification is thus not directly comparable with Frascati. For some purposes it is more useful, for other purposes it is less useful. It depends on the questions being asked.

Fisheries:

The "primary purpose" classification is more related to the reason for doing the R&D, whereas Frascati describes the nature of the work itself. However, perhaps coincidentally, there is a close relationship between the primary purpose code and the Frascati heading in the case of the work undertaken by DAFS Fisheries Research Services. PP code 3 is equivalent to "experimental development", PP code 5 is "applied-specific"; PP code 2 is mostly "applied-specific" with about 10% of expenditure in the "applied-strategic" category.

SHHD (CSO):

The "primary purpose" classification is broader based than Frascati. Again CSO funded health research is a small part of a large block and it is questionable whether the "primary purpose" classification adds anything to the exercise.

SED:

The primary purpose of SED's research activities is applied specific research so the "primary purpose" definition accords with Frascati.

SDD:

The "primary purpose" classification is more easily recognisable for our interests i.e. support for policy.

IDS:

All out spending on Economic Research falls within "primary purpose 2"—support for policy formation and implementation. SDA spending falls within "primary purpose 8"—Technology Transfer. The question of advantages of the primary purpose definitions over Frascati definitions is not particularly relevant in the IDS context.

Question 10. In the 'Annual Review of Government Funded R&D' there is an "apparent discrepancy" between the amount that Government says it spends on R&D in industry and what industry says it receives from Government? How does this situation arise and how can it be improved?

Answer 10. IDS, DAFS, SHHD, SDD, SED:

Research work is mainly commissioned in-house, or with universities or other research establishments. Very little R&D work is commissioned with industry. Thus the Scottish Office has no comment on this question.

Question 11. It has been suggested that the number of scientifically and technically qualified personnel employed on R&D is a better indicator of R&D effort than is the figure for R&D spending. Do you agree?

Answer 11. Agriculture:

No. It is important to have an understanding of the different costs of different types of research. Within Agricultural R&D, capital costs tend not to be as high as in some other branches of science. "Expenditure" may thus equate reasonably well with "effort", without too much distortion. Across scientific sectors, "manpower" may well be a better guide because of the very high capital and non-salary costs involved in some types of research but this could be misleadingly interpreted as an index of total investment in R&D for the sector concerned.

Fisheries:

No. It is not a good idea to use the number of technically qualified personnel as an indicator of R&D effort, rather than the financial expenditure. To emphasise performance measures based on head counts rather than real money would not give those in charge of research programmes the right incentives to be economical.

Scottish Office

Liaison Division

Dover House

Whitehall

14 July 1989

Memorandum by the Training Agency

Q1. We follow the Frascati definitions in broad terms but this varies slightly from the definitions we use in our day-to-day operations.

Q2. Broadly the definitions we use in our day-to-day operations are the same but they relate more specifically to our policy and programme requirements than the Frascati definitions.

Q3. We have in the past experienced some difficulty in converting our R and D spending into the format required for the annual Review because of the way our R and D budgets are set up. However, this year the problem will largely be resolved because all research should be funded from one central budget.

Q4. The problem in the past has been that the Frascati definitions and those we use in our day-to-day operations are not an exact match but this has never been a major problem for us (see answer to Q2).

Q5. Yes in broad terms.

Q6. We are fairly happy to work with the Frascati definitions as they stand. Supplementing the "basic" and "applied" research categories with a "strategic" research category in the way OECD suggests would only serve to complicate the issue. Similarly we see no advantage in trying to sub-divide the "experimental development" category in the way suggested by the US Department of Defence.

Q7. The vast majority of R and D funded by the Agency can easily be identified as "applied research". Examples here include projects to develop the application of new technologies such as artificial intelligence, expert systems, computer based training, simulation and interactive video. It also includes applied research evaluating programme such as YTS, Technical and Vocational Education Initiative and Employment Training.

Q8. We have not included any activity which falls outside the Frascati definitions of R and D.

Q9. In compiling our figures for the Annual Review we see some advantage in retaining both the Frascati definitions and the "primary purpose" classification because they cover different dimensions: the Frascati definitions relating specifically to types of research and the primary purpose classification describing essentially the subject matter.

Q10. As this is not a matter which concerns the Agency we do not feel qualified to answer this question.

Q11. No we do not agree that this would make a better indicator of R and D effort because only a small amount of our R and D is undertaken in-house.

Memorandum by the Universities Funding Council

COMMENT ON INTRODUCTION

The Universities Funding Council (UFC) requires every university it funds to submit an annual return showing its income and expenditure. Part of this return is concerned with income and expenditure specifically related to research grants and contracts and other services. The definition of research and other services used for this purpose is based on the OECD (Frascati) manual.

The remainder of the return is concerned with activities including teaching and research, which is financed from general income of which the UFC grant is part. A description of the UFC's role in funding university research is given in the 'Annual Review of Government Funded R&D'.

ANSWERS TO SPECIFIC QUESTIONS

Q1. Yes.

Q2. Yes, to the extent that we need to use definitions of research in day-to-day operations.

Q3. The UFC analysis of university expenditure involves a process of estimation by the Council Executive, based on information in the annual financial return. This information does not enable a reliable estimate to be made of year-on-year changes in the balance between basic, applied and experimental research.

Q4. No explanatory notes are used. The estimating process involves a degree of subjectivity in estimating what proportion of staff costs are attributable to R&D.

Q5. The Frascati definitions are adequate for the purpose of (c); the UFC does not seek to make the distinctions in (a) or (b).

Q6. The UFC does not seek to make these distinctions.

Q7. Specific examples from the university sector, if required, would have to be provided by the universities themselves.

Q8. No.

Q9. Not for the university sector. University academic staff who are wholly paid from general funds are required to do research as well as teach and the balance of effort is not related to their qualifications. For R&D which is financed by research grant or contract, the figure for spending is a better indicator of R&D effort than the number of qualified staff paid for from such funds.

Memorandum by the Welsh Office

I return answers to the questionnaire enclosed with your letter of 19 May.

Although we are a small Department we are multi-functional and there are some variations in procedures in the various Divisions. However, our answers reflect the general position.

ANSWERS TO QUESTIONNAIRE

1. Yes.
2. Yes.
3. No.
4. Explanatory Note to Annual Review.
5. Yes.
6. Frascati is adequate.
7. Table 1-2 is compiled by DTI. Example of 7(C) is 'Development of "Welsh dimension" to "National Educational Resources Information Services" (NERIS) computer database'.
We have no experimental research.
8. None that can be identified.
9. We are a comparatively small spending Department as far as R&D is concerned and our spending is classified in the Annual Review by primary purpose. We find this is a very practical classification in terms of dealing with enquiries but we would be content to fall in with other departments.
10. No specific queries or complaints have been addressed to us about this alleged discrepancy. We are not therefore in a position to answer this question.
11. We do not agree that just measuring numbers of personnel would be a good indicator of effort. This concept is naive in the extreme. For example, in relation to R&D funding in the NHS, the level of funding is often directed at assisting personnel to undertake research and is quite low but their salaries are paid from other sources. Such an indicator would give a very misleading assessment of the value of the funding.

Letter from Professor Keith Hartley, University of York

Definitions of R&D

Thank you for your letter of 31st January, inviting comments on the Committee's enquiry into definitions of R&D spending.

A study of definitions could be valuable if it assembles a data set, makes recommendations about regular statistical reporting and provides a comprehensive survey and critique of the limitations of definitions and their uses.

I have a number of comments on the enquiry and the draft letter and questions to witnesses;

1. *Aims of the Enquiry.* These need to be clearly specified and understood. The enquiry assumes that innovation depends on R&D—but the role of other factors cannot be ignored (e.g. size of firms, market structure, profitability of the firm and of its R&D, etc).
2. *Inputs v. outputs.* The focus is on R&D which is an input rather than the resulting output in the form of marketable ideas. Why not ask about the successes of R&D expenditure (including diffusion)?
3. *Definition of R&D inputs.* Distinguish between:
 - (a) Manpower and equipment in R&D
 - (b) Quality of manpower and equipment—e.g. how experienced are scientists, engineers, etc. who are used in R&D?
4. *Role and use of human capital*
 - (a) Consider the possibilities for substitution: firms might use different ratios of scientists to support staff, depending on relative input prices (i.e. using cheaper inputs to replace expensive inputs). ask firms about their use of support staff. Also, this need to be recognised in international comparisons.
 - (b) QSEs in different nations might have different lengths of training: hence different skill inputs into R&D.
 - (c) QSEs also acquire knowledge through experience of working on problems—e.g. ask firms how experienced are their OSEs (e.g. years since qualification) and where such experience was acquired (which other industries—e.g. defence)?
 - (d) Consider also the employment of QSEs as managers outside the R&D process—e.g. ask firms how many of their staff are QSEs and how many work on R&D activities.

5. *Collaboration* It might be interesting to ask firms involved in collaborative defence projects (e.g. Tornado, EFA) whether their answers differ between national and international projects.

6 *Specific points on questionnaire*

- (a) Clarify the meaning of "other activities" in (a). Do you simply mean all non-R&D expenditure, or do you want a further classification?
- (b) To help respondents, the links between sections (a-b) and (i-iv) need clarifying.
- (c) For whom is the questionnaire designed? Some questions seem to be aimed at firms, others at academics, analysts and policy-makers e.g. why would a textile firm be interested in defence R&D?
- (d) For defence R&D, distinguish between private and publicly-financed defence R&D. In selecting your sample, include some firms involved in both defence and civil markets (e.g. GEC).
- (e) Questionnaire is too vague and needs to be more specific.

7. *A Proposal.* Why not ask firms to provide actual data on R&D, for, say, 1987-1988, using their definitions and then Frascati—in each case, the basis of the calculations would need to be shown. Similarly, ask for total employment of QSEs, distinguished between sub-groups (e.g. engineers) and total numbers. Such data would need to be related to firm aggregates of sales and employment.

Please do not hesitate to let me know if you need clarification on some of these points.

20 February 1989

Keith Hartley

Letter from the Organisation for Economic Co-operation and Development

The Secretary-General has asked me to thank you for your letter of 31st January 1989 concerning the Sub-Committee which the House of Lords Select Committee on Science and Technology has set up to enquire into the definitions of R&D, and which is expected to contribute to the forthcoming revision of the standard OECD guidelines on this topic "The Frascati Manual 1980".

I enclose initial comments (Annexes 1 and 2) on your draft letter to witnesses which have been prepared by the Scientific, Technological and Industrial Indicators Division of the Directorate for Science, Technology and Industry which has managed successive revisions of the Frascati Manual since its first version in the 1960s.

I understand that members of your group will be visiting the STIID of the OECD early in March to discuss this matter further.

22 February 1989

T. J. Alexander,
Head of Secretary General's
Private Office

ANNEX 1

STIID COMMENTS

Whilst appreciating that invitations to witnesses should be as simple and as short as possible, we feel that some points might be made more explicitly, especially regarding the Frascati Manual.

- (i) R&D is only one of a family of scientific and technological activities which contribute directly or indirectly to "industrial and national investment in innovation". Some witnesses may criticise the definition of R&D because they are more interested in these other activities. OECD is developing guidelines for the Technological Balance of Payments, for various aspects of information technology and for overall innovation surveys.
- (ii) Establishing a definition of R&D is only the first step towards obtaining satisfactory data. In order to use the definition, it is necessary to develop guidelines and conventions for specific sectors, industries, etc. much of the Frascati Manual is taken up with such additional guidelines, conventions and examples. For example, a special addendum will shortly be published dealing with the measurement of R&D in the Higher Education sector. The bare quotation of the definition in the draft letter to witnesses, thus, oversimplifies the matter.
- (iii) The distinction between basic research, applied research and experimental development is only one of the functional subcategorisations of R&D in the Manual. It is central to the system of R&D statistics in the United States and is currently of great interest in the United Kingdom. It is however not taken so seriously in many other OECD countries.
- (iv) We note that only "R&D spending" is covered. The Frascati Manual covers both R&D expenditures and personnel. The inclusion of the latter in the exercise might add to its utility.
- (v) We note with interest the attention paid to military and civil R&D. A special effort will be made in the revised manual to provide better guidelines for measuring military R&D, and any help in this area would be appreciated.

ANNEX 2

EXISTING DEFINITION OF R&D
(SUGGESTED REDRAFT)1. *The Frascati Manual: The source of Existing Definitions*

The definitions, conventions and classifications of R&D used in the UK official surveys are largely based on "The Measurement of Scientific and Technical Activities, Proposed Standard Practice for Surveys of Research and Experimental Development Frascati Manual 1980", OECD Paris 1981. This Manual is essentially the work of the Group of National Experts on Science and Technology Indicators (NESTI) drawn from the 25 OECD Member countries. The basic definitions in the Manual are also used in a number of non-OECD countries and by UNESCO. In addition to these basic definitions, the Manual also includes additional guidelines and conventions as to how R&D should be measured in different sectors and fields. For example, an addendum to the Manual dealing with measuring R&D in the Higher Education sector will be published shortly.

R&D is only one of a wide range of scientific and technological activities. OECD is currently working with experts from Member countries to provide similar manuals for the Technological Balance of Payments, Information Technology Statistics, Innovation Surveys, etc.

2. *The Frascati Definition of R&D*

In the Frascati Manual, research and experimental development (R&D) is defined as:

"creative work undertaken on a systematic basis in order to increase the stock of knowledge, including knowledge of man, culture and society and the use of this stock of knowledge to devise new applications".

A number of criteria are given for distinguishing R&D from other activities. The most popular ones, which are often quoted in the instructions in national R&D surveys, are as follows:

"the basic criterion for distinguishing R&D from related activities is the presence in R&D of an appreciable element of novelty" and, at the borderline between R&D and industrial activities".

"If the primary objective is to make further technical improvements on the product or process, then the work comes within the definition of R&D. If, on the other hand, the product, process or approach is substantially set and the primary objective is to develop markets, to do pre-production planning or to get a production or control system working smoothly, then the work is no longer R&D."

3. *R&D by Type of Activity*

The Frascati Manual divides R&D into three general categories:

1. Basic Research
2. Applied Research
3. Experimental Development

Basic Research is defined as "experimental or theoretical work undertaken primarily to acquire new knowledge of the underlying foundation of phenomena and observable facts, without any particular application or use in view".

Applied Research is defined as "original investigation undertaken in order to acquire new knowledge but is directed primarily towards a specific practical aim or objective".

Experimental Development is defined as "systematic work, drawing on existing knowledge gained from research or practical experience that is directed to produce new materials, products or devices, to installing new processes, systems and services, or to improve those already produced or installed".

A number of examples of the application of these definitions in various fields of science and technology are given in the Manual.

Letter from Dr P. Stoneman, University of Warwick

RE: DEFINITIONS OF R&D

Thank you for your letter of 31/1/89 asking for comments relating to the work of Sub Committee II. There are some general points that I would like to make, even though they might not relate directly to your question.

1. There is a general impression that current R&D statistics under-represent the technological efforts of small and medium sized enterprises. For example SPRU data suggests that small firms account for a much larger proportion of innovations than R&D. As it is unlikely that small firms are more efficient in their R&D processes, this implies that R&D in small firms is understated. Perhaps their R&D is not formal and thus not classified as such by the firms.

2 Design or production engineering activities may be important inputs into technological change. Current definitions exclude these.

3: Technology transfer activities of various kinds are excluded from Frascati but may be an important technological activity. Perhaps these should be included in Frascati.

4. Current collection of R&D statistics in the UK only details work undertaken in the UK. As R&D undertaken overseas by UK companies may be an important technology source for UK companies, perhaps the statistics ought to extend to this.

5. I have the impression that software development ought to be classified as R&D. My understanding is that at the present time this is not so.

6. Statistics on UK government funded R&D and UK Industrial R&D are not collected on a compatible basis. I believe your committee should explore this problem. Is there a Frascati definition that could be used to make them compatible?

7. Only limited data is available on the civil/defence breakdown of Industrial R&D. This should be improved.

I hope these comments are of some use to you.

6 February 1989

Paul Stoneman

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